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SCHOOL SCIENCE
AND
MATHEMATICS

VOL. XXV, NO. 2 FEBRUARY, 1925 WHOLE NO. 211

OBSERVATIONS ON FACTORS DETERMINING SUCCESS IN PHYSICS.

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The writer is convinced of the great value of objective measurements in evaluating school work. With the formulation of various types of tests to estimate more accurately various aspects of school activity, more definite conceptions of these aspects will be formed and further analytic work of a similar nature will be stimulated. In formulating a series of subject matter achievement tests for use in this study, perfection of testing subject matter achievement is not claimed, nor is it presumed that subject matter achievement is necessarily the only, or even the most valuable quantity to measure. The two phases of the subject primarily considered in the tests are what might be termed non-mathematical information and mathematical information. These are probably considered two fairly distinct phases by every experienced Physics teacher. Many of the new courses being formulated in our secondary school curricula at the present time tend to introduce more non-mathematical scientific subject matter. These assume that general conceptions of scientific methods and scientific facts are useful to the ordinary individual without a very definite mathematical treatment being essential to procure them. On the other hand, there is a belief on the part of many of the necessity for a more complete mastery of scientific procedure and concept built upon a quantitative knowledge, a mathematical concreteness, not obtained by extracting the numerical data.

Unquestionably, what should be offered to the student is what he needs most in his everyday contacts; but such a declaration does not in itself settle the matter. The writer leans strongly to the conclusion that no two individuals should be

expected to gain the same benefits from a course in Physics; that always there must be a selection by each student with the helpful advice of the teacher, the selection being determined by the immediate and expected future needs of the student himself. The solution of this problem awaits a more conclusive decision as to the aims and purposes of the course in connection with the function of education. For the time being, the assumed purposes of the course may be considered as (1) the acquisition of information concerning physical laws, concepts, and theories which may aid the pupil in everyday life, and (2) the ability to solve practical problems involving this information.

Seven tests have been devised: viz., Metric and English Units, Simple Machines, Mechanics of Liquids, Mechanics of Gases, Forces and Strains, Motion and Acceleration, and Sound. With the exception of the one on Metric and English Units, each test is divided into two parts, a non-mathematical section and a mathematical section. The attempt was made to make each test as objective as possible and valid from the standpoint of well recognized subject matter of Physics. All questions are based on an outline of the course in Physics in Minneapolis, made out by the teachers of Physics working in conjunction. Data on reliability has not yet been obtained, but results of several of the tests given in different Minneapolis high schools are gratifyingly similar, so that validity and reliability will be assumed until further data has been secured. More tests, covering the remaining parts of the field of Physics, are being devised and steps taken to secure standardization for all the tests.[1] The results from the seven tests mentioned have been used as measures of achievement in Physics.

I.

One query naturally presenting itself was the relationship between mathematical and non-mathematical information. To partially answer this query, the scores in the non-mathematical and mathematical sections respectively of the tests mentioned were added and the coefficient of correlation computed by the Pearson Product-Moment Method. For a group of 93 pupils taking all the tests, the coefficient is $.798 \pm .013$ which indicates a rather higher degree of correlation than had been expected by the writer. While, in general, either mathematical or non-mathematical questions will measure fairly accurately subject

[1]This article was written in March, 1924. Tests to measure the whole subject matter of Physics have now been constructed and temporary norms are available.

matter achievement for a group of this size, there are certain individuals who do better with one type of question than with the other. To be fair in measuring all pupils, both kinds of questions should be included in any given test. It is evident that even though one type alone might give a fair measure of a large group with reference to other groups, certain individuals would not recieve their just rating.

It should be noted in this connection that none of the mathematical questions given in the tests are of such a nature as to require complicated mathematical operations involving large numbers. An effort has been made to eliminate testing ability in adding, subtracting, multiplying, or dividing, these being made as simple as possible. In some cases, as in the test on Simple Machines especially, mathematical operations are merely expressed so as to avoid lowering the scores because of mistakes in fundamental arithmetical operations.

Does such a high correlation mean that it is unnecessary to have pupils spend much time in working out concrete problems applying the laws and principles? Not at all. To settle that point, differentiated work should be given to equal groups with problems given to one group and omitted with the other. Such an experiment[2] was performed last year by the writer with his classes in Physics. The results of this experiment indicate value in time spent by the pupils in solving problems in the subject of "Heat" at least. Probably the same conclusion could be drawn concerning other branches of the subject as well.

II.

Another interesting question involves the effect of past school work on success in Physics. Do students who do good work in Physics also do good work in Mathematics, English, History, Industrial Arts, Languages, and other work in Science? Can success in these other school subjects be used to predict success in Physics? Is there any relation between success in Physics and scholarship in general?

In order partially to answer these questions, school marks in each subject were obtained and correlated with the total scores in Physics in all the tests including both the marks on mathematical questions and the non-mathematical questions. Teachers' marks for all work done in High School were obtained. In order to get a rating, a mark of A was counted as 4, B—3, C—2, and

[2]Hurd, Archer W., "A Topical Method Compared With a Problem Method in the Acquisition of Information and Ability to Solve Problems in the Subject of 'Heat' in Physics." Master's Thesis, University of Minnesota—1924.

D—1 and in the statistical work, the numbers carried to two decimal places. The coefficient of correlation between marks in Mathematics and the added total scores of seven tests in Physics was found to be .73±.03 for 86 pupils. This is not far from the correlation between the mathematical and the non-mathematical scores in the Physics tests[3], which seems to indicate a high degree of relationship between past work in mathematics measured by teachers' marks and the mathematical work in Physics. This past work in Mathematics consisted almost wholly of two years of Unified Mathematics as offered in the ninth and tenth years in North High School, Minneapolis. Physics followed in the junior year.

The coefficient of correlation between past teachers' marks in English and the combined total scores in the six Physics tests was found to be .59±.046 for 83 pupils, showing a substantial degree of relationship between English and Physics, though considerably less than that between Mathematics and Physics, which might be expected. Apparently a great many of the pupils who had good scores in the Physics tests also had received good marks in English from the English teachers. The question might suggest itself here as to whether certain pupils get good marks in school subjects because of other qualities than excellence in the subject. Pleasing personality, engaging manners, industrious attitude, or spirit of co-operation, might influence the teacher's judgment. The answer to this question awaits definite results of research work. It can be partially answered, however, by uniform results obtained by correlations between various teachers' marks—or the lack of such uniformity.

The correlation between the same scores in the Physics tests and past teachers' marks in Science (General Science and Biology) was found to be .47±.077 for 48 pupils (only 48 pupils having had past work in Science). The low correlation is explained partially by fairly high marks in Science gained by eight pupils of the 48 who had low scores in the Physics tests. They are without exception quiet, courteous, fairly industrious and co-operative pupils, showing that marks in General Science and Biology in North High School are probably not given entirely on knowledge shown in tests.

The correlation between the same scores in Physics and the marks by the writer in the semester's work in Physics during which all these tests were given, is .95±.006 showing that in

[3]This was .798 ±.013.

Physics the tests were quite accurate measures of the semester's work, though other factors, including Laboratory work, industrious and co-operative attitudes, together with evidences of initiative, entered into the final decision in making up the marks.

The coefficient of correlation between scores in the Physics tests and teachers' marks in History for 45 pupils is .44±.08, while that obtained for 42 pupils between the same scores in Physics and teachers' marks in Industrial Arts, comprising Manual Training and Domestic Science, is .37±.087.

From all of these correlations, it seems that success in Physics in North High School can best be predicted from teachers' marks in Mathematics and least from teachers' marks in Industrial Arts. Success in English will have some value in predicting success in Physics, while that in General Science or Biology and History are of much less value. Probably as Physics is taught at present, pupils who have a very difficult time with mathematics should decide that their abilities do not lie in the direction of Physics and choose some other field for their activities. Possibly many of those who are interested in mechanical work, but are poor in mathematics, might be successful in Industrial Art subjects. If they had expected to enter the engineering profession, they had best change their intentions, but may receive some consolation in remembering that Edison, though eminently successful as an inventive genius, hated formal mathematics and hired mathematicians to do his mathematical work for him.

Thinking it might throw more light on the situation, the correlation was computed for 78 pupils between the added scores in the mathematical parts of the tests in Physics and teachers' marks in Mathematics, .75±.03 being the obtained coefficient, the result not being much different than that obtained when the added total scores of the tests were compared with the teachers' marks in Mathematics.

It may be noticed that subjective judgment has been largely eliminated in the marks given by the writer to his pupils in Physics. Whether or not test marks alone should constitute the chief evidence in ranking students might be disputed by some teachers, but a vote of the pupils used in this study, taken after marks had been given, indicated clearly that the pupils themselves like the method and believe that the justice and impartiality of a series of objective tests makes it possible for

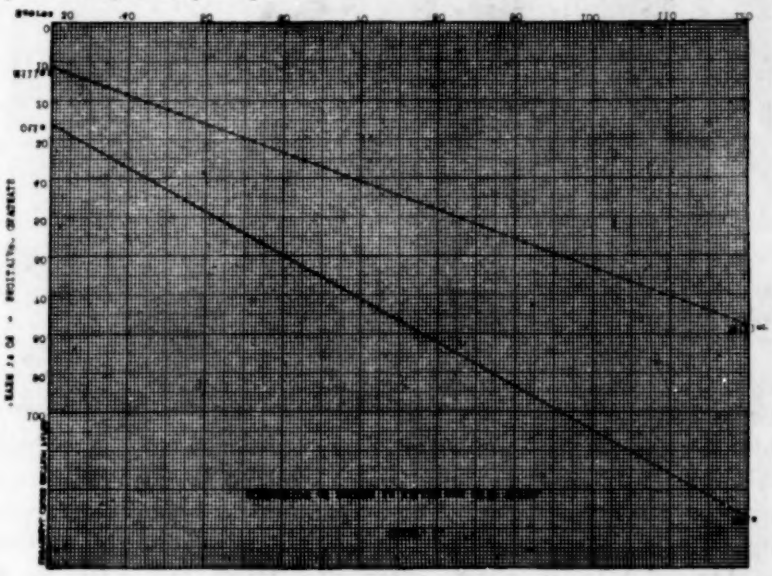
them to know better where they stand in the group and the exact basis for determining it. It might be worth while to know that after each test was given and scored, the results were tabulated and placed on the board in a conspicuous position, the individual scores and ranks being given together with the range and Arithmetical Mean of each of the four classes. In this manner, class rivalry and individual rivalry were stimulated to a considerable extent. The pupils' names, however, were not used, each pupil having been given a number designating him in all the tests. The numbers were given in such a way that the arrangement was not one that would make it easy for any pupil to tell who was designated by each number and the identity of the individual was thus kept secret from the other pupils. The writer, himself, could tell a very few individuals by number even after having worked with the data for a long time.

The correlation was computed also between the tests in Physics and total scholarship, the latter being obtained by averaging the teachers' marks in all subjects, the result being $.69 \pm .037$, thus falling short of that between the marks in Mathematics and the same tests but comparing favorably with that between the tests and intelligence ratings.

III.

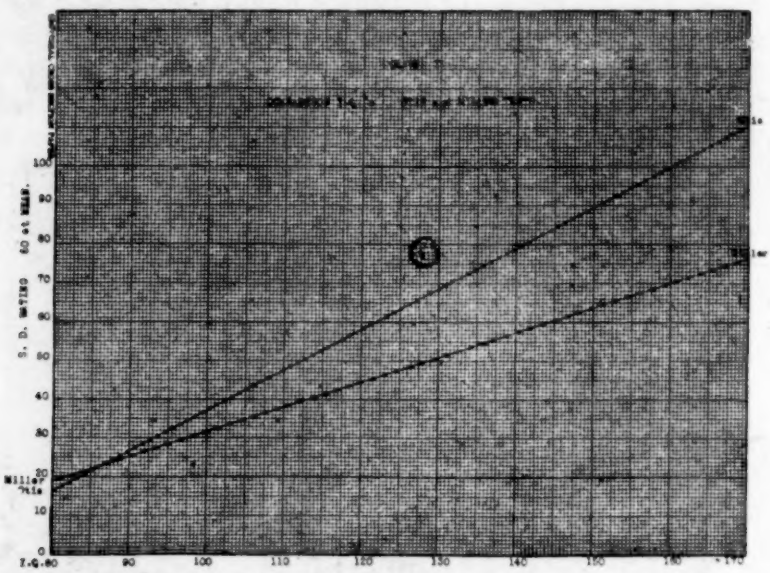
Nothing has so far been said concerning intelligence rating. In order to measure this aspect, two intelligence tests were given: viz., the Miller Group Test, Form A, and the Otis Self-Administering Group Test, Form A. The Standard Deviation rating of each pupil was worked out from the results of each test and the Mean of the two ratings used as a measure of intelligence. The correlation between the added scores in the tests in Physics and the Intelligence ratings was found to be $.68 \pm .03$. This correlation is somewhat higher than the usual run of correlations between teachers' marks in various subject matter tests and Intelligence ratings, which might indicate that instruction was more nearly adapted to the capacities of all the individuals in the group than is usual, or that all pupils more nearly equalled one another in effort exerted than is usual. Whether or not the results of such tests should correlate highly with intelligence ratings might be an undecided question with many. However, if every individual is prevailed upon to put forth the same effort and instruction is adapted to the capacity of each individual, the correlation should be high. These conditions are probably

not attained in present-day teaching, though they are ideals sought for by many teachers. Whether they are the ideals which should be sought for is a question in the mind of the writer. What is the function of the subject being taught? If it is indentical for all students in the class, perhaps the above should be the ideal condition to be attained. If, on the other hand, the subject merely presents material which may be used in developing each pupil, one in one way, another in another, because the needs of no two pupils are identical, then the problem of subject function becomes a more complicated one with many difficulties to be overcome before it is solved. The correlation spoken of would be high also if no instruction by the teacher were given and each pupil worked equally hard in securing necessary information with the same means at his disposal. So no claim is made that because of the considerable degree of correlation obtained, the instruction was better than ordinary. It may show either good instruction or not much of any instruction. The best criteria for determining the quality of instruction would be the gain made by the pupils before and after instruction, in terms of the units in which instruction is given, an ideal not prevailing widely at present.



A note at this point concerning the intelligence tests used might be worth while. As stated heretofore, the Miller Mental Ability test, form A, and the Otis Self-Administering test,

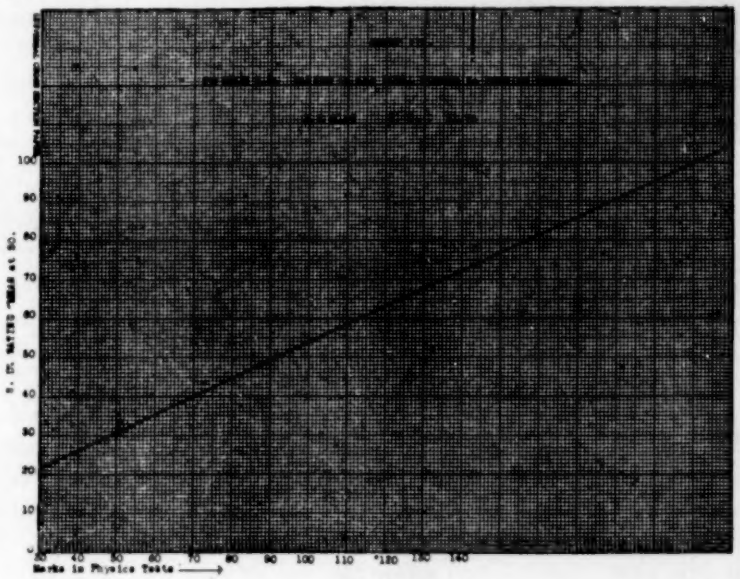
form A, were given. Charts I and II[4] are for the purpose of translating scores in one test into scores in the other, and I. Q.'s computed from one test into I. Q.'s computed from the other. The Mean of the scores for 98 pupils in each test is placed on the 50—S. D. Rating line, and the Computed Standard Deviation in each test, respectively, laid off to the right and a vertical distance 10 points (representing one S. D.) vertically upward. From the two points thus obtained, a line is drawn for each test. Reading the Score for any pupil in either test along the bottom scale, following upward to the line of the test to get the S. D. Rating, and finding the equivalent Score in the other test corresponding to the same S. D. Rating, is an easy matter. Chart II deals with I. Q.'s rather than scores in the tests. These equivalent scores or I. Q.'s are not necessarily the ones obtained by the pupils but the ones they obtain if they maintain the same S. D. Rating in each test.



Tracing to find equivalent scores was done for many pupils and S. D. ratings are quite similar, though not identical, there being a few variations. The correlation between scores in the two tests gives similar data. It is $.737 \pm .03$, not as high as that obtained between certain other intelligence tests. Dr. W. S. Miller[5] has data covering results of each of these tests as measures of intelligence compared with the mean results of five other

[4]Miller, W. S., University of Minnesota, suggested the method used in the Charts.

intelligence tests given to a large group of pupils, showing that each of the Miller or the Otis tests rates pupils approximately the same as the Mean rating of the five tests. Apparently neither shows up as superior to the other in thus rating pupils, so the writer followed the plan of using the Mean S. D. ratings of the two tests as the basis of rating in this study.



IV.

A question might present itself concerning the work done by boys and girls in the subject of Physics. In order to throw some light on this matter, the rating of the 21 girls in the group was compared with that of the whole group in both intelligence scores and scores in the tests in Physics. There were 65 boys in the group thus taken, making a total of 86, who had taken both intelligence tests and all of the tests in Physics. From Chart III the S. D. rating of each pupil in the total Physics test scores may be obtained. The Mean rating of the girls in intelligence was found to be 52.2, with an S. D. of 7.1, the Mean for the whole group being 50, with an S. D. of 9.3, thus indicating a superiority on the part of the girls. The Mean of the girls on the tests in Physics, however, was found to be 86.5 with an S. D. of 17.21, while the Mean for the whole group was 88.4 with an S. D. of 21.9, thus showing some superiority of the boys in Physics. The boys seem to be more nearly accomplishing

[1]Unpublished.

results according to their capacity than are the girls. Probably the different degrees of interest alone might account for this seeming superiority, though the difference is hardly great enough to be a significant one. The most correct interpretation of the above data would probably indicate that there is little or no difference between the boys and girls as the subject was taught. In order to get data from which more reliable conclusions could be drawn, it would be necessary to have a greater number of girls in the group. There is apparently a little less variability among the girls as indicated by the S. D.'s given.

V.

A comparison of classes is worth while in order to investigate any noticeable differences. The whole group constituted four classes of 26, 26, 26, and 28 pupils, respectively, meeting for recitation the first three days of the week, the second, fourth, sixth, and seventh periods of the day, respectively, there being double laboratory periods on Thursday and Friday. Does time of day seem to produce any effect?

Finding the Means of the total scores in the tests in Physics by classes, the results were found to be 90.68, 91.32, 87.30, and 88.23, respectively, for the classes in the same order as above. In order to compare the classes, their intelligence ratings should receive consideration. These were computed from the results of the Otis Test scores alone (before the Miller test was given) and were 49.82, 53.74, 49.84, and 51.16, respectively, with S. D.'s of 10.74, 8.02, 7.3, and 7.6, respectively. The fourth-period group has the highest intelligence rating, the others in order being the seventh, sixth, and second periods, though the differences are probably not significant. The seventh-period class consisted of 12 girls and 14 boys, this class having the largest proportion of girls, there being more than all of the others together.[6]

The fourth-period class also had earned the highest Mean scores in the tests in Physics, followed by the second, seventh, and fifth. The similarities in the scores by classes attracts attention perhaps more than the differences, as the latter are not really significant anyway. The somewhat lower scores of the sixth-period group in Physics could be explained by the fact

[6]Later, the intelligence ratings by results from the Miller test were computed, giving Means for the classes in the same order—77.45, 84.58, 82.54, and 82.16, the fourth-period being highest as before, with the sixth, seventh, and first following in order. This slight variation from the other order in the sixth and seventh changing places does not affect any conclusion drawn.

that the sixth period immediately follows the second lunch period, their study period coming the second lunch period, a somewhat unsatisfactory condition. The slightly higher scores of the fourth-period group can be explained by their slight superiority in intelligence and the fact that possibly the fourth period, just before the lunch period, may be conducive to good work. The second period is also apparently a little preferable for recitation work, shown by the higher scores of this group, though the intelligence rating is lower. It will be noticed that the seventh-period class recitation does not follow a period for study as do the others. Instead of reciting the eighth period, as would be logical (the second period of the double period used on laboratory days) the meeting time was made the seventh, to enable some of those who worked in the afternoon to leave earlier on certain days of the week. The lack of as well arranged a study period, together with the presence of so many girls, might account for the somewhat lower scores in Physics. All in all, however, there seems to be no significant difference as regards time of day.

There was in evidence in the fourth-period class a competitive spirit which might have some bearing on the slight apparent superiority of this class in Physics. This class was noisy, argumentative, and spirited. In trying out, for a part of the semester, a scheme whereby pupils helped to choose the activities for the next day's work, it was found almost necessary to have committees appointed to act for this class in order to prevent undue excitement, the spirit of rivalry being especially prominent, with marked differences of opinion. Apparently the noisy class was not the poorest class by any means. It might prove instructive to investigate further the relationship between good work and noise. At present, no reliable conclusions can be drawn. To be sure, distinctions should be made between types of noise.

If homogeneity of a group is desirable for greater progress, the results shown by the class No. I (S. D. = 10.74) meeting the second period should be poorer than that of any of the others. Instead, these pupils stand second in actual test scores. Their difference in variability, however, is not great enough to warrant any particular conclusions being drawn concerning desirability of homogeneity. None of the groups is really a homogeneous group.

(*Continued in the March issue*)

HURDLE TESTS IN ALGEBRA.

By Kate Wentz,

Manual Training High School, Indianapolis, Ind.[1]

The idea of the Algebra hurdles used in the Emmerich Manual Training High School of Indianapolis was suggested by Murray A. Dalman, now Director of Reference and Research of the schools of that city, and formerly an instructor in the Emmerich Manual Training High School. To the teachers of the Mathematics department of the school belongs the credit of working out the details of the scheme.

The hurdles consist of groups of sets of tests of graduated difficulty. Each group of tests contains four sets on the same topic. The first or C set involves only minimum essentials. Each of the other sets, B, A, and A+ contains more difficult applications of the principles involved than the preceding set.

Samples of the different sets of the addition group given below will illustrate:

C.

Add:

(1)	(2)	(3)	(4)	(5)
−5	−8	−2	5	0
−3	2	4	−5	−2

6. $-3+5 = ?$
7. $2-9 = ?$
8. $-4-4 = ?$
9. $-6+6 = ?$
10. $3-5 = ?$

B.

Add:

(1)	(2)	(3)	(4)
−3	8	−7	4
−4	−6	6	−4
5	−2	2	−6
2	3	−3	6

5. $4-5-2+6 = ?$
6. $-3-8+6+1 = ?$
7. $-7+3+5-4 = ?$
8. $5-6+3-2 = ?$

[1] Hurdles, A Series of Calibrated Objective Tests in First Year Algebra, in the Journal of Educational Research, Jan., 1920, pp. 47-62.

A.

Add:

(1)	(2)	(3)	(4)
−12	11	16	−13
− 6	− 4	− 9	− 5
−19	−17	−14	17
13	9	− 8	− 9
7	15	9	14

5. 19+8−7+13+6 = ?
6. −5−14+17−3+16 = ?
7. −9+17−8−13+5 = ?
8. 6−12+14−16+3 = ?

A+.

Add:

(1)	(2)	(3)	(4)
26	−47	−33	28
−39	19	19	−17
17	−18	−47	−19
−48	38	−14	35
−25	−27	16	47
19	−42	−29	−39
34	15	37	−27
−14	26	46	−16

5. 15+29−17−35+13−49−18+43 = ?
6. −39−18+15+29−14−27−19+38 = ?
7. −17+49−13−17+9−8−11+29 = ?
8. 27−19−8−35+16+47+17−38 = ?

Other topics for which groups of tests, or hurdles, are used are: evaluation, subtraction, division, linear equations, factoring, addition of fractions, fractional equations, simultaneous linear equations, and quadratic equations.

Lessons designed to develop the principles of each topic precede the giving of the hurdles belonging to that topic. Class discussion, drill, and home work assignments are used to secure an intelligent grasp and a working knowledge of the subject. The method of giving the hurdles is as follows: On the first test day each pupil in the class takes a C test. Those who fail to make 100 per cent take another C test on the second day, while those who have succeeded try a B test. On the third day of the tests those pupils who have failed for the second time on

the C must make a third attempt. Those who passed the B test may try an A. Those who have tried the B and failed make another attempt on a B test. On the fourth day, some pupils are working on a C test, some on B, some on A, while those who have not failed on any of the first three are working on the highest or A+ test. Other privileges to take a C test in any topic are offered later in the semester to those pupils who fail in all four of the opportunities just described. No additional chances, however, are given to make a grade above that of C.

For this scheme it will be seen that in every group of tests four C tests are needed, three B's, two A's and one A+. The different sets of any one grade are so constructed that while the problems given involve different numbers, each set presents questions of the same type and the same degree of difficulty. One C set must not be more difficult than another C set. All B sets must be of the same degree of difficulty and type, and so for the A's and A+'s. The full set of subtraction hurdles given below will illustrate:

C^1.

Subtract:

(1)	(2)	(3)	(4)	(5)	(6)
3	0	2ab	4xy	−7	−10hk
−9	−2xy	−2ab	12xy	3	−2hk

(7)	(8)
−2r+3s−t	3b−2c
5r+ s−3t	2a−b

9. From 2a−b−7c take b+2c−a.
10. Subtract 5x−y−2z from −2x+y−z.

C^2.

Subtract:

(1)	(2)	(3)	(4)	(5)	(6)
−3xy	2ab	0	9	−12a	−2ab
3xy	7ab	−hk	−6	14a	−7ab

(7)	(8)
−3a+2b−c	2a −c
7a−b−3c	a−3b+2c

9. From 2a+3b−c take −2b−a+5c.
10. Subtract 2x−y+5z from x−4y+7z.

*C*³.

Subtract:

(1)	(2)	(3)	(4)	(5)	(6)
3xy	0	−11	−2ab	2bc	xy
7xy	5ab	7	−3ab	−7bc	−xy

(7)	(8)	
3a−7b−c	2k	2r
−2a−3b+5c	3k−m	

9. From $2m-5r+7t$ take $-t-5m+2r$.
10. Subtract $a+7b-2c$ from $-2a-b+c$.

*C*⁴.

Subtract:

(1)	(2)	(3)	(4)	(5)	(6)
−3ab	−12	−2mk	3xy	−ab	0
7ab	8	−5mk	−5xy	ab	−3ab

(7)	(8)
−3x+ a−m	−3d+f
5x−2a−m	3c−2d

9. From $3h-k+p$ take $2k-p-5h$.
10. Subtract $r-s-3t$ from $3r-2s-t$.

*B*¹.

1. Subtract $2x$ from $a-b$.
2. From $3mk+2kr-3mr$ take $-5kr+mr$.
3. From $x-2y$ subtract $a+b$.
4. Subtract $2a-a^3+5a^2-1$ from $a^2+3-a+a^3$.
5. From $-a^{\frac{1}{4}} - -b+c^{\frac{2}{3}}$ subtract $-a^{\frac{2}{3}} - -b^{\frac{1}{4}} - -c^{\frac{1}{3}}$
6. From $3k^3-k^2+2$ take $5k^2-k+3$.

*B*².

1. From c^3+2c^2-5 take $3c^2-c+1$.
2. Subtract $2x^2-x^3+3x-7$ from $5x+2-3x^3+x^2$.
3. From $xy-2xz$ take $-2xy+3xz-2yz$.
4. From $a-b$ subtract $c-d$.
5. Subtract $2x$ from $m-n$.
6. From $-a^{\frac{2}{3}} - -b^{\frac{1}{2}} + -c^{\frac{3}{4}}$ take $-a^{\frac{3}{4}} + -b^{\frac{2}{3}} - -c^{\frac{1}{3}}$.

*B*³.

1. Subtract $3x-x^3+5-x^2$ from $2-x+x^2-x^3$.
2. From x^3-2x^2+1 subtract $3x^2-x+5$.
3. From $-\frac{3}{4}a-\frac{2}{3}b+c$ take $a-\frac{1}{4}b-\frac{1}{3}c$.
4. Subtract $3m$ from $a+b$.
5. Subtract $a-b$ from $a-b$.
6. Subtract $2x-y$ from $3z-2y$.

*A*¹.

1. From $-2x^3+y^3-3x^2y+2xy^2$ subtract $-y^3-x^2y+2x^2+3xy^2$.
2. Subtract $5a^3+3a^2b-2b^3$ from $-3a^3+3ab^2-b^3$.
3. Subtract $-\frac{1}{3}a^2-\frac{5}{6}a+3$ from $-\frac{3}{4}a^2+\frac{2}{3}a-1$.
4. From $2x^2-3xy-5y^2$ subtract the sum of x^2-xy+y^2 and $5xy-2y^2$.
5. By how much does -1 exceed 7?

*A*²

1. From $5a^2b-2a^3-ab^2+b^3$ subtract $2a^3-3ab^2+b^3-3a^2b$.
2. Subtract $2x^3+3x^2y-y^3$ from $5x^3-2xy^2+y^3$.
3. Subtract $-\frac{1}{2}m^2-\frac{3}{4}m+2$ from $-\frac{1}{3}m^2-\frac{1}{2}m-5$.
4. From $x^2-2xy+y^2$ subtract the sum of x^2-y^2 and $x^2+3xy+y^2$.
5. By how much does 3 exceed -8?

A+¹.

1. From the sum of $-x^3-3xy^2-y^3$ and $5x^3+2x^2y-2y^3$ take the sum of $2x^3-xy^2+5y^3$ and $-x^3+3x^2y-y^3$.
2. By how much does $2x^2-xy+y^2$ exceed $2x^2+xy+y^2$?
3. By how much does -2 exceed $a-b+c$?
4. From the difference between $-\frac{2}{3}x^2-\frac{3}{4}x+5$ and $-\frac{1}{4}x^2-\frac{2}{3}x-3$ subtract the sum of $2x^2-\frac{3}{4}x+\frac{2}{3}$ and $-\frac{1}{4}x^2+\frac{2}{3}x-1$.

No definite number of minutes has been worked out for the giving of the tests in class. The practise has been to leave the time to the discretion of the teacher, and even so, the grading obtained through the use of the hurdles has proved rather satisfactory. A careful study of the time element would doubtless add to their efficiency.

The pupils' papers on which all solutions are correct are destroyed by the teacher. Papers containing errors are returned to the owners at the beginning of the class period on the day of the next test. Pupils who do not receive papers can set to work immediately on the next higher test. The teacher is thus free to give additional help to those students who have failed. This help may take the form of group or individual teaching as seems best. As soon as a pupil's difficulties are removed, he is put to work on a new set of questions of the exact type on which he has failed, and he has a chance to make another attempt to jump that particular hurdle.

Posted records of success add much interest to the work and indicate the number of efforts each pupil has made. A pupil's grade in any topic is that of the highest hurdle he is able to pass in the four chances allotted to him for the hurdles of that topic. The grade at any marking time is the average of the grades of C or above, obtained on the different topics.

An interval of one day between the first and second hurdles has often proved a day of most effective teaching. Failure on the first C hurdle brings the pupil to a realization of his difficulties and reveals to the teacher those points which need additional emphasis before the second hurdle is attempted.

The hurdle scheme has been found valuable for several reasons:

It makes assignments definite for both teachers and pupils. Each teacher has a book in which is a sample of each set of questions in every group—a book which thus prescribes not only the topics to be taught but the degree of difficulty in the problems to be mastered in those topics. The pupil is left in no doubt as to what he must do to obtain any particular mark.

It not only puts a responsibility on all pupils for the accomplishment of minimum essentials, but affords opportunity for ambitious pupils to do work of more advanced type than can be accomplished by the slower members of the class.

It makes group teaching possible in classes where I.Q.'s may have a wide range of variation.

The hurdles stimulate interest. The fact that the hurdle is "on" challenges the attention of the laggard.

Slow people are afforded opportunities to prove that deficiencies have been made up.

The hurdle scheme is not a device for teaching algebra. It will not take the place of skill on the part of the teacher in stimulating thought or in training pupils to express mathematical relations in algebraic language, but it will help the teacher to a more exact knowledge of the extent to which his teaching has accomplished its purpose.

It is extremely improbable that a set of hurdles which are useful in one school would prove equally satisfactory in another. Each school should make its own hurdles and incorporate therein the practical ideals of that school. Because of the rapidly changing conditions in most high schools, hurdles that meet the needs of one school year may require revision for the following year.

The sample hurdles below are given in the hope that they may prove suggestive to teachers interested in working out sets to meet the needs of their own schools:

EVALUATION.

C.

If $a = 2$, $b = -3$, and $c = 6$, find value of:

1. $b+c+a$.
2. bc.
3. b^2.
4. b^3.
5. a^3.

B.

If $a = -4$, $b = 3$, and $c = 2$, find value of:

1. $5a+b+c$.
2. a^2b.
3. a^2+b^2.
4. $2a^3b^3$.
5. a^3+b^3.

A.

If $a = -3$, $b = 2$, and $c = 5$, find value of:

1. $2ab+3b+c$.
2. $-3ab^2$.
3. $2a^2+5b^2$.
4. $2a^3+3b^3$.
5. $\frac{bc}{2}$

A+.

If $a = -2$, $b = 3$, and $c = 4$, find value of:

1. $5a+2a^2c+b^2$.
2. $-2a^2b^3$.
3. $-3a^2b+2ab^2$.
4. $2a^3b+3b^3c$.
5. $\frac{a^2b}{2}+\frac{b^3}{3}$

DIVISION.

C.

Divide:

1. x^2-x+12 by $x-4$.
2. $6x^2+11x+3$ by $3x+1$.
3. a^3+b^3 by $a+b$.
4. $20-18x+6x^3-11x^2$ by $2x-5$.

B.

Divide:

1. $13a^2-4+12a+a^4+6a^3$ by a^2+3a+2.
2. $16y^4-1$ by $2y+1$.
3. $10x^3-3+11x-21x^2$ by $5x^2-3x+1$.

A.

Divide:

1. $12x^2+\frac{7}{12}x+\frac{1}{12}$ by $3x+\frac{1}{3}$
2. $m^4+m^2n^2+n^4$ by m^2+mn+n^2.
3. $4x^2y^2+y^4+7xy^3+2x^4-x^3y$ by x^2+3y^2-xy.

A+.

Divide:

1. $10x^2y^4+16y^6-25x^5y-49x^3y^3+12xy^5+6x^6+31x^4y^2$ by $3x^2-2xy+4y^2$.
2. $-\frac{1}{12}a^2+\frac{25}{12}a+12$ by $-\frac{1}{4}a+4$.

EQUATIONS.

C.

1. The perimeter of a rectangle is 190 yards. The base is four times the altitude. Find the dimensions of the rectangle.
2. Divide $161 between A and B so that B shall receive $13 more than A.
3. Solve $5x-(2x+1) = 7-x$. Prove the result.
4. Solve $8(x-1)-6 = 2$. Prove the result.

B.

1. A farmer wishes to enclose a rectangular field for a pasture, making it 54 rods wide. He wants to make it as long as possible, using 278 rods of wire fencing which he has on hand. How long can he make it?

2. The sum of two consecutive integers is 217. Find them.

3. Solve $(x+1)(x+19) = (x+3)(x+13)$. Prove.

4. Solve $\frac{x}{6} - \frac{x}{12} = 5$. Prove.

A.

1. The sum of the ages of A and B is 48 years. In 12 years B will be twice as old as A. Find their ages.

2. The sum of two consecutive odd integers is 256. Find them.

3. One-third of a certain number exceeds one-eighth of it by 10. Find the number.

4. Solve $13-(x-5)(x-3) = 3-(x-5)(x+7)$. Prove the result.

A+.

1. A man has $3.37 in dollars, dimes, nickels and cents. He has three times as many dollars as dimes, one more nickel than dollars, and as many cents as dollars and nickels put together. How many of each kind of coin has he?

2. A is now 63 years old and B is now 3 years old. In how many years will A be five times as old as B?

3. $3(2x+1)(5x-4)-5(2x-1)(3x-2) = 6(4x-3)$. Solve and check.

ADDITION OF FRACTIONS.

C.

(Results must be expressed in lowest terms.)

Simplify:

1. $\frac{a-b}{ab} + \frac{b-c}{bc}$

2. $\frac{x}{2(x+y)} + \frac{y}{3(x-y)}$

3. $\frac{3a}{a^2-9} + \frac{5}{3-a}$

4. $\dfrac{x-y}{x+y} + 1.$

B. (Results must be expressed in lowest terms.)
Simplify:

1. $\dfrac{2-x}{2+x} - \dfrac{2+x}{2-x}$

2. $\dfrac{2}{x^2-5x+6} - \dfrac{5}{x^2+2x-15}$

3. $\dfrac{X}{x^2-25} + \dfrac{X}{5x-x^2}$

4. $1 - \dfrac{2xy-3}{2xy+3}$

A. (Results must be expressed in lowest terms.)
Simplify:

1. $\dfrac{x+2}{x-2} - \dfrac{x-2}{x+2} - \dfrac{16}{x^2-4}$

2. $\dfrac{a+1}{a^2-a-6} - \dfrac{a+4}{a^2-4a+3}$

3. $\dfrac{1}{y^2-xy} - \dfrac{1}{x^2-xy}$

4. $3m+4 - \dfrac{9m^2+16}{3m-4}$

A+. (Results must be expressed in lowest terms.)
Simplify:

1. $\dfrac{1}{a+1} - \dfrac{a}{a^2-a+1} + \dfrac{a^2-4}{a^3+1}$

2. $\dfrac{3a+2}{6a^2-a-1} + \dfrac{a+3}{3a^2+7a+2} - \dfrac{a-2}{2a^2+3a-2}$

3. $\dfrac{x+4}{3x-6} - \dfrac{2x-5}{8-4x}$

4. $a-b-\dfrac{a^3+b^3}{a^2+ab+b^2}$

(In accordance with the custom which was started and explained in the December, 1924, issue, we present two comments on the preceding article, one by *Miss Mabel Sykes* of the *Bowen High School, Chicago*, and the other by *Claude E. Kitch* of the *Oak Park High School*. Teachers who would like to participate in these discussions should send their names to the editor.)

Discussion by Mabel Sykes,
Bowen High School, Chicago.

There are two great advantages in the Hurdle Test:

1. It emphasizes accuracy as an ideal of first importance.

2. It provides the teacher with a means of detailed diagnosis.

In the Hurdle Test 100 per cent is required. In administering such tests one is tempted to think that inaccuracy is a peculiarity of all young minds and that the standard of 100 per cent is too high. Herein is exactly the value of these tests. While the teacher should not be discouraged because of the everlasting inaccuracy of young people in the high school, accuracy as an ideal should be ever present. The Hurdle Test is not a time test. Speed is of secondary importance in mathematics and in everything that depends upon or is in any way related to mathematics. Mathematics that is not right is not mathematics. In a time test a pupil may be required to get 5 right in 4 minutes perhaps. If he has worked 7 exercises in the 4 minutes and 5 of them are correct he has passed his test; but the ideal of accuracy is destroyed or made of secondary importance only.

Two questions arise:

First. Are not the Indianapolis tests longer than is necessary in some cases? A test of this type should not require more than 5 or 10 minutes to administer. Testimony concerning the time required for these tests from those who have used them would be of value.

Second. If the questions on the test sheets were so arranged that answers followed one another either all horizontally or all vertically could not the papers be marked more quickly?

These two questions have a bearing on the second of the advantages mentioned above. If the tests were shorter and could be graded at maximum speed more than one test on a given topic could be given. For example, a test like the following on equations is valuable for diagnostic purposes. It should precede by some weeks the Indianapolis test on linear equations.

1. $4x = 20$
2. $x+2 = 9$
3. $x-4 = 3$
4. $\frac{X}{3} = 2$
5. $7x = 4$
6. $21 = 7x$

In grading the papers on this test it may have been noted that most of those who failed to jump the hurdle missed exercise 5. It is evident, therefore, that the class needs drill on exercises like number 5. Just here is the advantage of allowing a day or two to intervene before the test is given a second time. It is well to give a set of practise exercises in this interval as a preparation for the second trial.

It is of course difficult to make a set of Hurdle Tests that would be satisfactory with all books and all teachers. But a set can be made to fit any particular book desired.[2] When this is done the tests can be made very short and tests can be given on as many details as is desired. This is something more, evidently, than testing on the main broad topics of algebra as is the case with the Indianapolis tests. The diagnostic value of the tests is thereby increased.

DISCUSSION BY CLAUDE E. KITCH,
Oak Park High School

The idea of the "Hurdle Test" as worked out at Indianapolis has been clearly explained by Miss Wentz and the advantages emphasized by Miss Sykes. I shall therefore confine my remarks to my own reactions toward the tests and to a question raised by Miss Sykes.

In the first place I have always felt that the word "hurdle" applied to this series of tests was a misnomer. Especially to the athletic fans familiar with track and field events, the term is misleading. To the mind of such a person, the word "hurdles" suggests a series of obstacles to be jumped, all of which are of

[2]See Rand McNally & Company's "C B A Hurdle Tests" for *Sykes-Comstock's Beginners' Algebra*. Note the topics tested, length of test, arrangement of exercises, and drill exercises on the back of the sheets.

equal height. Now that is not the case with these tests. They are more like the "high jump" where the bar is raised for those who have cleared it at the previous height.

Of course, there is nothing in a name provided one gets the idea, and the idea is a good one. The tests are an incentive for the pupil to work up to the limit of his ability with 100 per cent accuracy. Complete mastery of a topic is the only thing that counts. The grades received by different pupils are in proportion to the difficulty of the test passed. This makes grading or marking very satisfactory to both teacher and pupil.

I have not used the set of tests as worked out at Indianapolis since coming to Oak Park seven years ago but have used the idea almost continuously. For various reasons I have made my own tests. In the first place I do not use the "hurdles" for all topics as I prefer a good speed test for those in which the process is easy and speed desired. Then I have felt that the Indianapolis tests were longer than necessary. Sometimes in a topic like simplifying fractional expressions I give only one problem on each test. For the "C" test I give a problem like

$$\frac{7x-3}{12x} - \frac{3y-1}{4y},$$

one which involves subtracting a polynomial numerator, and then proceed to more difficult ones for the "B," "A," and "AA" grades. Of course a longer test is desirable when time permits but one problem will test a knowledge of the process. I do not require a test to be done in a certain time; neither do I always wait on the extremely slow ones. When I think the pupils have had sufficient time, I read the answer and quickly collect the papers of those who have it. While this group is practising on more difficult problems, I go over the test with those who missed it. As soon as opportunity affords, I check the papers handed in and hand back any that contain mistakes.

While in some respects a standardized test is desirable, yet a great deal can be accomplished by careful selection of problems; and by making a new selection each time, the tests can be adapted to the particular class being taught and to the text used, and thus avoid becoming static.

I post the records on a chart, using a star made with a rubber stamp in the column under the grade of the test passed. This adds interest and takes very little time. The chart is designed to contain the record of all the tests given the class during one semester.

ACHIEVEMENTS OF PUPILS IN CHEMISTRY.

By Stephen G. Rich,

Essex Fells, N. J.

In the test-making vogue which has passed over the educationalists of this country in the past decade, chemistry has been the school science that has received the most attention. The earliest test for achievement in science courses was Starch's well-known completion test in physics; but chemistry, which did not come within the testing field until 1917, has far outrun every other science taught in schools in the number and variety of tests published. General science has been worked by two test-makers; biology, owing to its variability in content and emphases probably, has now only one published and standardized achievement-test.

Achievement in chemistry offers to date some results of considerable educational interest, since in it the line between high-school and college freshman attainment has been crossed by more than one tester. A further interest accrues from the diversity of purposes and points of view embodied in the tests of the different makers. It is not the purpose of this article to give primary attention to the tests, but rather to the results with their use; incidentally, however, some test-makers' purposes and viewpoints must be explained. At this point it must suffice to say that the tests used may be grouped into classes according to the following classification: those accepting the whole existent curriculum in the subject as valuable, and those testing in terms of educational values; those testing chemical achievement as a whole, and those testing it by sections of subject-

Table 1. Distribution of Scores in Various Chemistry Tests, for all Pupils completing One Year of High-School Chemistry, so far as reported.[1]

Test	Bell-Texas	Cleveland Cooperative Second Semester	Rich Gamma and Epsilon[2]
Unit of Scoring	Points (100 maximum)	No. of correct responses	T-Scores (McCall's Method).
Lowest	16	3	12
Mean	60.5	9.0	53.2
Q	9.1	.....	7.5
Highest	100	17	83
No. of pupils	392	282	221

[1]Data for the Bell-Texas computed from those in Bell, J. C., A Test in First-Year Chemistry. Jour. Ed. Psych., April, 1918. Data for Cleveland Cooperative partly from Hayes, Cooperative Chemistry Tests, Jour. Ed. Res., Nov., 1921 and partly original; data for Rich tests entirely original.

[2]Tests Gamma and Epsilon are equivalent and mutually convertible in respect to scores.

matter; those testing retention of information primarily, and those testing for other abilities also.

Whatever the nature of the test used, the workers are entirely in agreement in finding that the range of attainment at the end of a year of high-school chemistry is immensely great within any given class, any given school, any given system of schools, or any group of schools heading towards the same external requirement (e. g., preparing for College Entrance Examination Board examinations). The table on page 145 will illustrate the typical situations found:

Table 2. Results with typical classes at end of one year of high school chemistry. All are in New Jersey high schools except the Cleveland Cooperative, which is in a West Virginia High School.

Class and Test	1. Bell-Texas	2. Cleveland Cooperative Second Semester	3. Rich Gamma and Epsilon	4. Rich Gamma and Epsilon
Lowest	38	3	35.5	35.5
Mean	62.3	6.5	51	48.0
Q	5.0	2.2	6.0	6.3
Highest	84	12	68.5	60
No. of pupils	20	14	21	25

The significance of these results will be the more striking when the nature of the various tests is considered. The Bell-Texas test was drawn up to embody those items of information and ability which a college department of chemistry considered it essential for entering students to have. It is predominantly a test upon elementary information. The Cleveland Cooperative is entirely an information-test, and the form here used is entirely upon the work covered in the second semester in the schools of Cleveland, Ohio. The Rich tests are one-third memory, one-third chemical thinking, one-sixth numerical problems and one-sixth laboratory questions, all on material chosen from the existing curricula but having some discernible relation to the social aims of education.[3]

Through the courtesy of Dr. S. R. Powers, of Teachers College, New York, N. Y., the writer has been informed of exactly similar results, for classes and for schools alike, obtained through the Middle West with that worker's tests.[4]

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[3]The Bell-Texas test is not printed, but has to be duplicated for use, copying it from the article cited above. The Cleveland test is given *viva voce*; see loc. cit. The Rich tests are published by the Public School Publishing Co.

[4]Powers' Chemistry Tests, published by World Book Co.

The rate with which pupils progress in chemistry may be gathered from the following table of norms for two of the three tests used in the examples above.

Table 3. Means of attainments on Various Chemistry Tests during first year of High School Study of Chemistry.[5]

Time pupils have studied chemistry	¼ yr.	½ yr.	¾ yr.	1 yr.
Bell-Texas Mean No. of points	47.5	60.8	60.8	60.5
No. of pupils	63	50	47	392
Rich Gamma and Epsilon Mean T-Scores	43.5	46.0	49.1	53.2
No. of pupils	58	400	586	221

The nature of the Bell-Texas test, mentioned above, is such as to weight it unfavorably as a measure of progress in the second half-year. In spite of this, it indicates for the first half-year the same situation as the writer's tests indicate for the whole year: the rate of progress for the class as a whole is, for each half-year, *less than one-fifth of the range of attainment* of any class in chemistry at either the beginning or the end of the period over which the progress is measured.

The dispersion of scores, as indicated by any convenient measure, such as S. D., P. E. or Q, is substantially constant with these two tests throughout the first year of instruction. In table 1, Q is given for these tests; Q rather than any other measure is given because the Bell-Texas results as reported by Bell do not allow of computing either S. D. or P. E.

Dr. S. R. Powers has informed the writer that he finds substantially similar results with his tests.

The comparative achievements of pupils who begin chemistry in high school and those who begin the subject in college may be seen from the following results:

Table 4. Comparison of Attainment of Beginners in Chemistry in High School and in College.

Figures are Mean T. Scores on Rich Tests.

Time pupil has studied chemistry	¼ yr.	½ yr.	¾ yr.	1 yr.
High-School Pupils	43.5	46.0	48.1	53.2
No. of pupils	58	400	586	221
College pupils	46.2	51.2	50.6	52.3
No. of pupils	69	61	79	24

The small difference at any point between the total attainment of the high school beginner and the college beginner, and the *vanishing of the difference* after the first half-year are conspicuous features.

[5]Revised from the writer's article in School Science and Math., June, 1923, p. 539, as to Bell-Texas results.

The writer will be glad to furnish college teachers of chemistry with his tests in order to secure further data; it will be noted that the numbers of college students are small.

Pupils who have had a year or more of high school chemistry show, on continuing the subject in college, a comparatively small progress in total attainment in chemistry, as shown on the Rich tests. For such, the figures are as follows: ¼ year in college, 200 pupils, mean 55.1; ½ year, 90 pupils, mean, 56.7; ¾ year and over, 90 pupils, mean 57.4. These figures indicate that the traditional freshman course in "General Chemistry," required of those who offer chemistry at entrance, is far from being highly efficient in producing increase of attainment in the subject.

Objection might be made, however, on the ground that the tests used are possibly inadequate to detect the increased achievement. It may at once be said, as above, that the Bell-Texas test is thus inadequate after the first half-year of instruction. The Powers and the Rich tests are, however, made of material quite evenly distributed through the whole course. Attainment on either of them is probably as nearly a fair sampling of the total achievement as is obtainable in practice. The Rich tests, however, in that they eliminate all material of value only because of its logical position in chemical science, and test on material of at least presumptive relevance to health, social communication, home membership, vocation (other than that of research chemist), citizenship, worthy use of leisure time, and ethical character, are likely to discover *more*, rather than *less* advancement than has been produced by the instruction.

The writer believes that the time is now ripe for some progressive college or university to essay the experiment of allowing pupils entrance credit for chemistry when they present credentials in the form of scores above the means for those completing one year of high school chemistry, on any two of a list of seven standardized tests now available. Such two scores, eliminating the chance of error involved in any individual score on any one test, give a far more accurate representation of that individual's attainment in chemistry than does an old-line examination. In particular, the test-results, since they eliminate all weight due to legible or illegible handwriting, greater or less ability in English composition, varying speed of expression, and the like, are far more nearly an estimate of attainment in chemistry alone than the best of "essay-type" examinations can be.

Now that we have at least reasonably adequate instruments for testing achievement in chemistry, the way is open for the solution of some of the more urgent problems in which the totality of such achievement is a factor. In particular, the practical problem of reducing the unhomogeneity of the chemistry class may now be attacked, since the extent and degree of that particular factor—the despair of many a chemistry teacher—may be measured. Is it too much to hope for an extension into this field of the methods of classification by intelligence and achievement tests that have already shown their value in the elementary schools?

SCIENCE CLUBS URGED FOR HIGH SCHOOLS.

Science clubs should be encouraged in junior high schools, J. T. Shriner of the Latimer Junior High School of Pittsburgh told members of the National Educational Association meeting in Washington. Citing the interest in radio and automobiles among boys and girls of the seventh to ninth grades, Prof. Shriner said that it is in these grades that amateur scientists are developed.

The Science club gives the pupil an opportunity to develop and play with scientific hobbies and toys and rapidly leads to more constructive thinking, he said.

Boys taking the science course at the Pittsburgh high school learn to sew on buttons, mend tears in their clothing, press and clean clothing, and darn stockings as a part of their practical study.—[*Science Service.*

MERCURY BOILERS LIVING UP TO EXPECTATIONS.

The value of boilers using mercury vapor in the place of steam in power plants is justifying all expectations, declared W. L. R. Emmet, consulting engineer of the General Electric Company, addressing the World Power Conference at London. The efficiency of mercury vapor for developing power lies in its use of extremely high temperatures without excessive pressure and its adaptability to turbine engines. Also the heat of condensation can be used for making steam for auxiliary power or for other purposes.

The continued operation of a mercury boiler and turbine at the Dutch Point Station of the Hartford Electric Light Company has suggested modifications and improvements without developing additional difficulties, Mr. Emmet explained. Special boilers and fittings must be used suitable to the temperatures used. Leakage of mercury and mercury poisoning appear to be entirely avoided. Repeated measurements of the fuel used and the energy delivered show a saving of 50 per cent, in fuel with the mercury engine, together with other advantages of reduced space occupied and amount of water required. Mercury power is well adapted to locomotives and boats. The studies indicate a saving of 60 per cent. in fuel with improvements based upon the experience acquired at Hartford.

The supply of mercury for the increased demand which may follow a more general use of mercury for power purposes does not seem to be limited, Mr. Emmet said. Abundant sources of mercury are known and require only a slight rise in price to bring it upon the market, and other sources of supply will doubtless be revealed—[*Science Service.*

ASSEMBLY PROGRAMS FROM CLASS WORK.

By M. E. Herriott,
Supervisor of Science, University High School, Columbia, Mo.

It is a well established custom in the University High School of the University of Missouri to have about half of the assembly programs from the regular class work and prepared in the classes, although modified to suit the occasion.

The programs are proving valuable and beneficial in many ways. The following are the most outstanding:

1. They add purpose and reality to class work.
2. They force students to clarify and organize their work.
3. They are instructive and entertaining to the audience.
4. They help students to know what is taught in classes of which they are not members. This helps later in selecting courses which they want to take.

The following account of one of these programs is worth while for two reasons:

1. It is a fair sample of the programs, every bit of it coming from previous work, although amplified and arranged for the particular situation.

2. It shows how a successful program was conceived and worked out.

When it came time for the science department to furnish a program, it was expected that each class would have a share, but the physics class had an idea which they could not share and which was too big an idea to be only a part of a program; so it was proposed that the physics class take over the entire program. (The other classes gave another program later.)

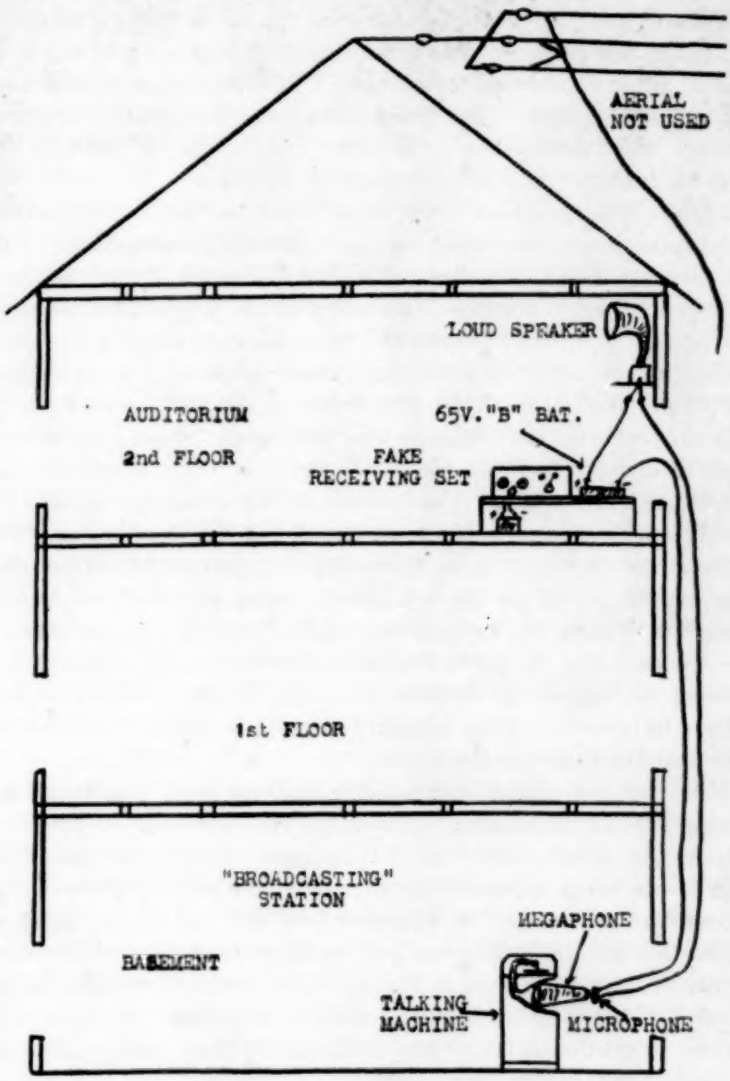
The big *idea* came about in this manner. Their teacher "put it up to them" to bring suggestions for the program, that it was *their* program. This was a day's assignment. The next day there were various proposals. Most of them suggested demonstrations which they would like to make. Then some one suggested that a radio program be given, but this was not feasible, for the program was to be at eleven o'clock and there was nothing "on the air." Some one spoke up with, "Why not use that transmitter and the loud speaker and fake a program?" (This boy had been trying to get the loud speaker and transmitter to work together as one of his physics experiments. He had not had success as yet, although confident that his theory was all right.)

The idea took hold immediately and enthusiasm grew. They combined with the fake broadcast idea their previous suggestions

of demonstrations. The following program of demonstrations was worked up:

1. Electroplating.
2. The Electric Generator.
3. House Wiring Systems.
4. Demagnetizing.
5. A Simple Telephone System.

The students were paired in these demonstrations, and each had a part. After setting up their demonstrations, they wrote



SET UP FOR A FAKE RADIO PROGRAM

up "lectures" to go with them. One student of the pair would write the "lecture" and then the other one would criticize it. Following this, the demonstration and lecture were tried out together. When the pair was satisfied that it was all right, they tried it on the class. This called for a revamping of both lecture and demonstration in the parts which did not "get across." The one criterion of judgment was, "Does the audience understand what you want to tell them?" There resulted some particularly good "popular" lectures on the subjects demonstrated.

When the program was given, the loud speaker was set in its usual place in the auditorium and a fake receiving set was used to make it realistic. The transmitter was placed in the basement where the "announcer," "lecturer," and "music" were. The set up is shown in the accompanying diagram.

One of the members of the class "tuned in" on the station and the announcer was heard by the audience to announce, "This is Station KSD, the *St. Louis Post Dispatch*, broadcasting a special program for the University High School at Columbia, Missouri." There followed the usual weather report, a musical number, and then, "I have the pleasure of announcing Professor Thomas Williams of the University of Toronto, who is in St. Louis and who has consented to lecture on 'Some Vital Phases of Electricity,' Professor Williams!"

Professor Williams (the teacher of the class, for he was the only one with a suitable voice) spoke of his pleasure in giving the lecture because of his friendship for the teacher of the class in physics for which the lecture was being given. Then he proceeded to read the lecture written for each demonstration.

To give the program realism, telegrams were announced as being received from various points in Missouri and even from Canada, expressing the pleasure of various people "listening in" to the excellent program.

At the end of the program the student body was invited to visit the "broadcasting station" in the basement. They had been completely fooled until that time. Some had praised the music as being especially good. The wife of the "lecturer" had been invited in for the program but was not in on the hoax. She did not recognize her husband's voice. One of the most enthusiastic radio fans in the audience positively *recognized* the voice of the lady announcer whom he had heard so many times over his radio, although the "announcer" for this program was a boy from the physics class.

The disillusionment of the audience was most interesting.

SUGGESTIONS FOR FIRE-PREVENTION AS A PROGRAM FOR GENERAL SCIENCE CLASSES.

By Fred T. Hart,

John Marshall High School, Chicago, Ill.

Many of the states are asking the public schools to have a day or two set aside for the study of fire-prevention. The logical place to study the details is in the classes of General Science. I have had much success with the following material, and the class has shown a good deal of interest in it. It has been given as an assignment for two or three days.

The loss by fire in this country is enormous, and part of it has to be borne by every boy and girl. A noted educator once said that every boy and girl who would be a good citizen should learn to protect his community and country against loss by fire. If we are to do this, we should study the causes of fire and a few principles of fire-protection.

Causes of Fires.

Carelessness. This is the greatest cause of fire, as shown by accurate statistics. You could make a long list of the careless things that you have done and that you have seen other people do, which lead to fires. A few of the outstanding causes due to carelessness are the use of matches, the unrepaired chimney, the flimsy goods we use for dress and decoration, the careless use of inflammable materials. The efficiency chart below will give you the twenty-five most common causes of fires in the cities.

Matches. There are two general types of matches upon the market; the common parlor match, and the safety match. Parlor matches are the most dangerous because they can be lighted on any surface which will give a slight friction. Small children can ignite them very readily. Parlor matches left on the floor might start trouble. If they are stepped on, fire may be produced. Mice can carry these matches between the walls and underneath the floors. Their nest might be near a chimney or the warm furnace pipes. These conditions have often caused dangerous and destructive fires.

The safety matches have the advantage in that they do not ignite so readily and cannot be started on any surface. Facts of this nature should be considered, especially in the homes where there are children.

Spontaneous Combustion. This is a condition where the fire starts without direct ignition. It is caused by a chemical action which starts very slowly, and grows faster until it generates

enough heat to reach the kindling temperature of the material concerned. It is hard to guard against, because there is generally no one around when the action starts. Some of the common causes of fire of this nature are collection of oily rags in closets, rubbish in heaps, large coal piles, and newly mown hay. Preventives of spontaneous combustion are good ventilation and cleanliness.

Experiment. To illustrate spontaneous combustion: Place a small piece of yellow phosphorus, the size of a pea, in a test tube containing about 3 c. c. of carbon disulphide. Roll a filter paper so that it will slip into the tube. Saturate one end of the filter paper with this solution. Unroll and lay the paper in an iron plate. Watch the action. The carbon disulphide tube must be stoppered and set aside.

Explain that this very thing may happen with certain oils such as are used by painters, and with furniture polishes.

Combustible and Non-Combustible Materials.

Substances that can take fire and burn readily are combustible. The following materials have been known to cause many fires on account of their low kindling temperatures: phosphorus, artificial and natural gases, acetylene, gasoline, kerosene, flimsy cotton and woolen goods, celluloid, turpentine, and paints.

Materials that are non-combustible and are used against fire are asbestos, concrete, metals, stone, slate, etc.

Experiment. Combustible Substances: Kindling Temperature. Place small amounts of sulphur, phosphorus, wood, clean sand, concrete, short distances apart on an iron plate. Start gently with the bunsen burner and then use the full flame against the pan. Questions. Which combustible substance has the lowest kindling temperature? Which the highest? What is necessary to make a substance burn? Compare wood, sandstone, and concrete as fire-proof materials for building.

Asbestos. Heat asbestos, cotton, and wool and explain the asbestos curtain and asbestos enclosures for moving picture machines.

Demonstrate the soda-acid fire-extinguisher. Generate carbon dioxide. Place a candle down at the bottom of a trough, and let the gas flow down this incline to the candle. Note what happens.

Fire Extinguishers.

Fire extinguishers are of two general types. The soda-acid extinguisher consists of a very strong tank which contains soda

in solution and a jar of sulphuric acid. The directions on the tank tell you how to use it. Carry the tank to the fire in an upright position, and as you approach the fire turn upside down. This causes the acid to mix with the soda solution. The result is a rapid chemical action which generates a large amount of carbon dioxide gas. The formation of this carbon dioxide creates a high pressure, which forces the water and the gas out through the attached hose. Carbon dioxide is a very heavy non-combustible gas, and acts as a blanket which settles down over the fire and shuts off the supply of oxygen.

The carbon-tetrachloride extinguisher is generally a pump affair containing the liquid which forms a vapor that is non-combustible. It is very efficient in putting out grease, gasoline and electrical fires, where the application of water is very undesirable.

Experiment. Use of carbon tetrachloride: Make a simple squirt gun and fill it with carbon tetrachloride. Make a fire of rags covered with oils. Try to put the fire out with water. Repeat, using small amounts of the carbon tetrachloride in the squirt gun. Discuss results. What types of fires are difficult to extinguish by use of water? What are the advantages of the carbon-tetrachloride fire extinguisher?

General Principles of Fire Fighting.

Oxygen is necessary for burning, and the knowledge of this fact will guide one in the early stage of the fire. The fire should be smothered, if possible, and all drafts shut off. For example, the housewife who is in contact with a gasoline or grease fire should not run to the open door and fan the blaze, but should use some means of covering the blaze and shut off the supply of oxygen.

An experiment should be given with gasoline to show how easily it is smothered by a blanket or an old coat. The gasoline should be in a vessel so that the liquid will not spread.

Before any substance will start burning it must reach its kindling temperature. This principle should be taught as a very important one in the prevention of fires. Water puts out a fire because it shuts off the supply of oxygen and keeps the temperature below that of the kindling point.

A Useful Chart to Arouse Interest in Fire Prevention.

The following chart is used in this way. A copy is given to each pupil and he is directed to take it home, and fill the blanks in the presence of his parents. The parents sign it and the

pupils bring the chart back the next day. At this time each point is discussed and the principle of the topic is impressed upon the student's mind.

A master chart is then made from these reports to show the cause of most of the fires in the local district.

GENERAL SCIENCE.

Fire Prevention Efficiency Chart.

To the student: Answer the following questions by the words "yes" or "no." If you use the word "no," put 4 per cent to the right of the word. When you have finished answering the twenty-five questions, add the numbers. This sum is the per cent of efficiency of your home, as to fire prevention.

1.	Do you use the common parlor matches at home?	....
2.	Do you use candles?	....
3.	Do you use kerosene for lights?	....
4.	Do you put dirty, oily rags in a wooden container?	....
5.	Do you use gasolene for any purpose?	....
6.	Is the gasolene within twenty feet of the house?	....
7.	Does the gasolene can lack red paint?	....
8.	Are any of the gas connections made of rubber?	....
9.	Is the fire place dirty?	....
10.	Does the woodwork around the stove lack metal protection?	....
11.	Have you ever seen your parents hunt for a gas leak with a match?	....
12.	Have you a wooden ash pail?	....
13.	Do your parents dry clothes within two feet of the stove?	....
14.	Have you any open gas jets?	....
15.	Is the roof of your house made of combustible material?	....
16.	Have you ever seen your parents use any liquid cleaning compound in the house?	....
17.	Have you ever seen your parents thaw water pipes with fire?	....
18.	Have you any loose rubbish in the basement?	....
19.	Have you any loose rubbish in the attic?	....
20.	Have you seen any loose wire insulation?	....
21.	Does the garage show any signs of grease?	....
22.	Does your yard contain dry leaves or rubbish?	....
23.	Does any member of the family smoke in the house?	....
24.	Have you mice in the house?	....
25.	Are you ignorant on the method of ringing a fire alarm?	....
	Efficiency	....

The average home is about 70 per cent efficient. Many are below this mark. We should be nearer the 100 per cent mark.

Carelessness is the great cause of fires.

Vienna and Chicago are cities of about the same size. Vienna had a fire loss of about $303,200; Chicago for the same year $5,513,237. If you are careful in making out your chart, I think it will tell you the cause of such a large loss in Chicago.

THE NEED AND USE OF A SCIENTIFIC MEASURE OF THE RESULTS OF THE TEACHING OF CHEMISTRY.

By HENRY L. GERRY,

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Accurate and scientific measurements in education are recognized as prerequisites to placing it upon the level of an experimental science. One of the characteristics of a science is that it is subject to accurate measurement. No exact science has developed beyond an embryonic state until its constituent parts have been quantitatively determined. Little progress was made in physics and chemistry as long as they remained fields for speculation. As soon as philosophers began to enumerate items and ascertain their extent, the subjects became less speculative and more scientific. If we are to give scientific answers to the questions that are constantly arising in education; and if we are to get scientific solutions to the educational problems that present themselves daily, we must abandon the speculative art and replace it with scientific measurement.

Before the standard test, scientifically constructed and scientifically administered, made its appearance, our measures of achievement in school subjects were very crude and unsatisfactory. Teachers' marks had no universal meaning. In fact even today, where standard tests are not in vogue, teachers' ratings are unreliable. This is due to the fact that (a) the terms used in describing the achievement of a pupil are vague and indeterminate, that (b) there is great variability in the passing mark, that (c) the values assigned to the different constituent parts of a student's performance are not consistently assigned by all teachers or even by a given teacher, that (d) teachers have no sufficient basis for the judgment of the quality of work that pupils do, that (e) an achievement of a given degree of merit is not rated the same if produced by children at different stages of educational advancement, that (f) marks are not distributed according to the probable distribution of achievement, that (g) many teachers are working in small schools and isolated communities where conference and consultation with other teachers similarly engaged is impracticable, and that (h) young teachers without prolonged experience and new teachers without opportunity for protracted observation are assessing educational attainments. These deficiencies will now be considered seriatim.

(a) There is no universal rating scale in use among teachers. Some describe the quality of work with adjectives, others use

letters for this purpose, and still others report the degree of achievement in percentage. To say that the work of student X is *fair* when that of Y is *good* not only does not tell how much superior is the work of Y to X, but also gives only a vague notion of the quality of work done by either one. No more clear cut is it to describe an educational product as *B* or *G*. Some teachers think that if they assign grades upon a percentile scale the record is concrete and definite. Percentage marks mean no more than literal descriptions. Gregory[1] has pointed out that a grade of 75 per cent represents an accomplishment of 75 per cent of *something;* no one knows exactly what. Certainly it is seldom 75 per cent of perfection. One who grades as 75 an English composition written by a sixth grade boy would not affirm that its quality represented three-quarters of perfection,—for what is perfection in English composition, anyway? Percentage marks as well as literal and verbal ratings can be interpreted only when one knows the standards of the school and the characteristics of the teacher giving them, and then only in a rough and approximate way..

(b) Teachers' marks on a percentile scale are not to be relied upon for comparative purposes because of a variability in the grade accepted as *passing*. This is known to vary from 50 to 80 among reputable schools. If this is so, it is readily seen that a mark of 65 per cent would mean quite distinct things in the two institutions represented by the extreme cases.

(c) The teacher's judgment of superiority among performances is not a judgment upon a simple thing. Rather it is a synthesis of personal judgments upon the elements of a complex affair. In chemistry, for example, one's final grade is based upon not less than his oral and written recitations, his laboratory technique, his notebook, and his examinations. No one of these items for estimation is a simple unit and the whole is exceedingly complex. Teachers are not consistent in their assignment of values to the contributing parts. Some teachers are known who give equal weight to recitation, to laboratory, and to examination. Others let the examination count for one-quarter of the final mark, and proportion the remainder between laboratory work and recitation. Recently there was received a set of grades for students of chemistry in which values were recorded to a degree of fineness as small as one-tenth of one per cent! Did this teacher give one-third credit to laboratory work, or two-fifths, or some

[1]Gregory, C. A., Fundamentals of Educational Measurement, p. 150.

other fractional part? Did he count the examination for one-third, or more, or less? One could not tell from his report; and so, even though there had been assurance that the contributing parts had been accurately measured and consistently combined, one could not compare his report with another's with safety. Furthermore individual teachers are not entirely consistent in their weighing of the constituents of a final mark. Teachers of chemistry have been known who, one month, would give considerable weight to the laboratory record; another, would not consider the laboratory note books at all.

(d) That teachers have no concerted opinion of the quality of some kinds of school products has been shown by a number of studies. Hughes[2] investigated the marking practices in 221 high schools. Only 35 of these knew approximately to what extent the highest, median, and lowest marks were given their students. In the small percentage of these schools where the distribution of marks was approximately known, the practices were so varied that a student passing from one of these to a certain other would thereby increase his chances for receiving the highest mark by 1,000 per cent. In 1912, Starch and Elliott[3] began a series of investigations of the reliability of marks. They submitted identical answer papers in each of three subjects, English, geometry, and history, to competent teachers with instructions that they grade them in accordance with the custom of their respective schools. When the results were tabulated and scores adjusted to a common passing mark of 75 it was discovered that the range of marks on one of the English papers was from 50 to 98; on a geometry paper, from 28 to 92; and on a history paper, from 43 to 90.

Similar lack of agreement has been shown by Hudelson[4] who had three teachers of long experience independently arrange ten English compositions in order of merit. In no case did all three teachers agree upon the merit of a single paper and in only one case was there agreement between two. The average magnitude of displacement of rank by any one judge from that of either of the other two was 3.4 places out of an average maximum of seven. In other words, the chances were nearly equal that any two judges were no more likely to agree on the rank of a paper than they were to disagree as much as the conditions of the experiment would allow.

[2]Hughes, W. H., Marks and Achievement, Educational Research Bulletin, Vol. 1, No. 3, p. 2.
[3]Starch, D. and Elliott, E. C., The Reliability of Grading, School Review, 20: 442-457; 21:254-59, 676-81. Starch D., Educational Measurements, pp. 3 ff.
[4]Hudelson, E., English Composition, Twenty-Second Yearbook of the National Society for the Study of Education, Part I, p. 32.

Science teachers are able to agree upon the quality of answers in a chemistry paper with not much greater success. The following questions and answers were distributed to several teachers of chemistry in secondary schools.

Please grade the following examination paper according to your best independent judgment, assuming that the highest mark that can be earned is 100 and that the passing mark is 70.

Question 1. Discuss the purification of drinking water.

Question 2. Discuss baking powders.

Answer 1. The three most common ways of purifying water are distillation, boiling and filtration. In the case of large quantities for public use, such as drinking water, filtration is the most inexpensive. The water is just piped from the nearest natural resource to the reservoir. The water is then filtered there. The filter is made up of three distinct layers. The first being gravel, the next coarse sand and the bottom layer fine sand. This sort of filtration removes nearly all the bacteria in fact all of the harmful bacteria. Sometimes if water is so impure that the impurities are visible a little alum put in the water settles it. Water that is purified by distillation of boiling, while it is just as good if not better than filtered water, has a flat disagreeable taste and these methods are too expensive.

2. Baking powders are made up of 3 different compounds. There are baking powders that contain alum, cream of tartar and phosphate. When water is poured on the baking powder in each of the three instances a reaction takes place which gives off CO_2. The CO_2 given off acts as the agent which causes the dough to rise. The alum baking powders are the most commonest not because they give better results but that the alum and other substances in the powder cost cheaper. The powders containing cream of tartar are also very extensively used, but however the other baking powders which contain phosphate are not as common. All of the baking powders however cause the same reaction that liberates CO_2 which is the most important task of every baking powder.

The scores assigned by 10 teachers ranged from 55 to 80 with as many giving it a passing mark as gave it a failing mark. This is, perhaps, an extreme example of an essay type of examination. Unfortunately, however, it is the kind of examination that some teachers use. That the quality of the answer must be measured in terms of what the teacher has taught probably needs no proof. That there would be a wide variation in scores assigned to identical answer papers by different teachers is indicated by the range of marks assigned by ten teachers.

A much more usual kind of examination, with a student's answers, was sent out from the New Haven High School by Mr. H. S. Johnson early in April, 1923. He received estimates of the value of the answers from 153 teachers. They range from 40 to 85 on a percentile scale. So wide a range of values cannot be attributed to different standards for passing, because tabulation of returns from schools with the same promotion requirements show equally wide variations. At the time of this writing[5] the data have not been published but a resumé of the

[5]March, 1924.

results will appear in the report of the meeting of the New England Association of Chemistry Teachers on December 8, 1923. This evidence of so great a range of marks enforces the opinion that teachers of science are not so scientific in assessing values of test papers as they ought to be.

(e) The same marks, given in two different school grades, mean entirely different things. A history paper awarded 80 in the sixth grade without doubt would be marked below passing in the twelfth grade. Although it were the same paper, the values assigned to it would be entirely different. In general, according to the prevalent present-day practice, a mark of 80 per cent in the sixth grade would mean a far different quality of work than that accorded 80 per cent in the twelfth grade. If chemistry were to be taught in the first year of the junior high school the average teacher would probably give a mark of 80 to a piece of work far inferior to that awarded the same mark in the senior class of the senior high school.

(f) An investigation of physical traits of a large number of individuals indicates that they tend to distribute themselves in the form of the Gaussian curve. If, for instance, the heights of a large number of men be measured, it will be found that there are a few who are very tall, a larger number who are above average height, a still larger number of average stature, a smaller number who are somewhat shorter than the average, and a very few who are very short. By analogy and from the measurements that it has been possible to make, it is assumed that mental capacity is distributed in much the same way. If this be true, it is probably fair to assume that ability (capacity plus training) and performance (ability plus utilization) will conform approxmately to the normal curve of error. Yet an investigation of teachers' marks indicates something far from a normal distribution. In 1917-18 the marks given by full time teachers in a small high school were distributed as shown in Table 1.

Besides the wide variation from the normal distribution shown by the marks of these teachers it is interesting to note especially the marks given by teachers E and F. Both taught commercial work exclusively and for the most part taught the same pupils; yet one gave more than twice as large a proportion of A's as the other. In the same school, the science teacher, who, perhaps more than any other member of the staff should have been scientific in his assignment of grades, gave fifty term marks in chemistry during the year. Of these the A's constituted 28%; and

B's, 24%; the C's, 38%; and the X's, 10%. Such wide variations from the probable distribution of quality of performances and such utter lack of consistency in marks assigned by different teachers to the same pupils in the same department help to substantiate the contention that teachers' marks are unreliable.

Table 1.

Distribution of Marks[6] and [7] *in a Small High School.*

Teacher	Number of term marks given during the year.	%A's	%B's	%C's	%X's
A	124	5.7	34.7	37.8	21.8
B	224	29.5	32.6	27.6	10.3
C	400	26.5	42.5	27.8	3.2
D	355	17.4	50.4	26.5	5.7
E	207	30.4	39.6	25.6	4.4
F	223	14.3	26.4	47.5	11.7
G	223	17.9	30.4	35.4	16.3
H	210	18.1	50.5	24.7	6.7
Normal distribution within ± 3 sigma[6]		6.5	43.3	43.3	6.5
Normal distribution within ± 2.5 sigma[7]		10.0	39.4	39.4	10.0

(g and h). Finally, there are two groups of teachers whose marks are especially likely to be unreliable for purposes of comparison. These are (1) teachers who have little opportunity to confer with other teachers and compare the results of teaching, and (2) teachers who are without experience in assigning values to school performances. A teacher who has no opportunity to find out what others are doing may quickly get a biased notion of the importance and value of elements of the teaching unit and, therefore, give marks based upon the biased notion. These will be quite as unreliable and meaningless as those given by a teacher who has never known and has not yet had opportunity to learn the separate values of the component parts of the whole.

In addition to these causes of the unreliability of teachers' marks, which have been mentioned and briefly discussed; there is at least one other factor that leads to unsatisfactory ratings and that makes more intense the belief that it is necessary to find more satisfactory measures of achievement than those already in use. This factor is embodied in the general concept of the subjectivity of marks. It has already been pointed out[8] in a previous article that teachers tend to ask a conventional number of questions, five, eight, or ten, and to assign them equivalent values,

[6] "A" is the highest mark given and "X" denotes failure.
[7] Calculated from table on p. 310, Yule, Theory of Statistics.

twenty, twelve and one-half, or ten without making a scientific effort to make them equal in importance or difficulty. If weights are to be assigned to questions they should be determined in some objective way, such as by the degree of success that pupils have with them, or by the value of the items in subsequent courses or in use. The former method cannot be used until the test has been taken; the latter usually involves more labor than a teacher is willing to devote to the preparation of an ordinary examination. That the value of a question cannot be predetermined by subjective judgment has been pointed out by several. Recently Kruse[9] has shown this for biology. He notes that in June, 1920, nearly fifty per cent of the Regents' papers in biology were graded as failures, and that, from the very nature of the case and from the success of the same pupils with other examinations, this could not have represented the true distribution of accomplishment of the students in biology.

The experimental work by Starch and others, to which reference has already been made, points out very clearly that teachers in different schools have quite different standards of work. In the case of the chemistry paper that ten teachers graded, it was pointed out that the same number gave it a passing mark as gave it a failing mark. It is also common knowledge that teachers' standards in different departments of the same cosmopolitan high school are widely variant. In chemistry, for example, the same demands are not made of pupils in the technical and commercial curricula as of those who are preparing for college. In the lower grades of some school systems different demands are made of pupils of different degrees of ability. In relatively few high schools has this practice been inaugurated; and where it does prevail, it has not, in general, reached the upper years where chemistry is ordinarily taught. It is, however, a movement that seems to be spreading upward in the school system and that must soon be taken under consideration in administering secondary schools. Such variations in standards among schools, departments, and abilities make the interpretation of a mark of 85, for example, very difficult. Would it not be better to grade all pupils on the basis of the same objective scale and then determine, if deemed desirable, the levels of attainment to be demanded of a given school, department, or ability?

Scientific tests of achievement may also serve a very useful

[8]School Science and Mathematics, 24:796.
[9]Kruse, P. J., Rural School Survey of New York State, Administration and Supervision, p. 452.

purpose in helping to determine the content that may profitably be included in a course of study. Since instruction in chemistry was first given in the secondary school, the original materials have been somewhat changed and the amount has been much extended. Modifications have been made upon the basis of changes in the college and not of the appropriateness to the secondary school. At the present time, for example, there is a tendency in some quarters to base the teaching of valence upon the electron theory without attempting to learn if this is a better basis than that previously used, if the material is suited to secondary school pupils, if the time and effort are reduced, or if the results of instruction are appreciably better. As there is no measure of efficiency in this procedure so there is no measure of the most effective proportion of qualitative and quantitative work for a secondary school pupil. In one large high school that has recently come to attention, the teacher does not require the solution of any problems based on the gas laws. His impression is that the work cannot be satisfactorily done in the time that can be devoted to it. But he has no measure of the amount of mastery that his pupils can get in a week or any quantitative measure of what other teachers are accomplishing with their pupils in a greater or in a less time.

In much the same way, as measures of achievement, chemistry tests or scales may be used to evaluate methods of teaching. Among chemistry teachers there is a belief that laboratory exercises should precede the recitation but no extensive quantitative experiments have been carried out to prove the truth or falsity of this belief. With a sufficiently accurate measuring stick it would be possible to asssse the results achieved by equivalent groups by this method and by its reverse and to draw a valid conclusion as to which is the better. In a similar manner, by properly devised and conducted experiments, it would be possible to offer something more than snap judgments on other questions of method, such as these: Is the *lecture* as profitable an exercise for secondary school pupils as other types of classroom exercises in which the student participates? Are the results obtained with an elaborate and expensive laboratory equipment commensurate with the cost? Should the student be supplied with simple or complex apparatus? Does he learn more from an individual experiment or from a well-executed demonstration? Are there sufficient sex differences in the mastery of chemistry to make it desirable to employ a different method with girls than with boys?

It seems almost unnecessary to have to point out the direct uses of chemistry tests as measures of the amount of information possessed. In some schools, students begin chemistry with a background of general science, biology, and physics. All of these other sciences contribute something to chemistry. If we may know at the beginning of a course the amount of information about chemistry that the class has acquired from other sources, the work may go ahead without repetition and to the much greater profit of all. Furthermore, it is desirable to know the advancement that a pupil has made in a year's work. This cannot be known unless his position at the start has been ascertained. If this be determined and the same measuring stick be used to determine his position at the close of the course, his gain may be expressed in definite terms. Likewise, it is possible to determine and express in objective terms monthly or half-yearly changes, or to compare classes year after year. Comparisons of this sort cannot be made with the type of examination usually given by the teachers; with a standard test they are possible.

For the substitute teacher, the standard test is a great boon. It sometimes seems that the regular teacher falls ill more often near the end of the school term than at any other time. When this is the case, the substitute must present and correct an examination. Usually he does not know where emphasis has been put in the work and, therefore, does not know what to stress in the examination. If students do not do well with his test he is accused of making it too difficult, of asking questions on topics that had not been taught, or of grading too severely. If there is available a standard test with country-wide norms, the substitute may present this. If the material is inapplicable or if the students do poorly the blame, if there be blame, cannot be attributed to the substitute. In such a case the original teacher has not been teaching the usual kind of course or the group is not a normal one.

Incidentally, standard tests may be used as teaching devices. As a result of their mechanical construction they stimulate mental alertness. When a student has replied *yes* to a question that should have been answered by *no;* has marked a statement *true* when it is *false;* has mismatched given statements; or has supplied wrong words to blank spaces his errors may be pointed out to him and, usually, he sees the inconsistency and absurdity of his replies. In short, by vividly pointing out inaccuracies, loose

thinking, and lack of information these tests stimulate to the positive virtues of accuracy, careful thinking, and more extended learning. In general, the use of tests as teaching devices is not to be recommended. They are designed as instruments of measurement and not as vehicles for the presentation of ideas. Their questions are carefully selected and probably cover an essential range of topics. To know the answers to these questions is an acquirement better than none, but to use them for drill reduces, if it does not destroy, the trustworthiness of the test as a measuring instrument.

It is probably true, also, that a standard test of wide range more nearly approximates a true measure of the accomplishment of a pupil than does the ordinary examination. A standard test, by requiring a minimum of writing, makes it possible to cover, in a given time, a far wider range of topics than can be done in an ordinary examination. It is thus possible for a student who might fail on one-tenth of an ordinary examination, to fail on that same and no other item in the standard examination and thus be unsuccessful with one one-hundredth of it. On the other hand, the test over a wider range and including a larger sample of topics might discover a greater proportion of topics with which the student was unacquainted than would the ordinary examination. Therefore, from the point of view of mere scope, the standard test is more likely than the ordinary examination to get a true measure of the pupil's achievement. Furthermore, the teacher's average test is obnoxious to most pupils. They approach it in an unpleasant state of mind and do not give their best efforts to it. On the other hand, the standard test is novel, it introduces unusual situations, it arouses interest, it calls forth a student's best efforts.

There is need of a test in chemistry, or of a series of tests, that may be used to help diagnose pupil's difficulties. This is not easily done upon the judgment of the teacher nor by the use of the ordinary examination. With properly devised tests, however, it may readily be done. It would be helpful with stochiometric problems, for example, to have a careful analysis of every step in every kind of problem and a series of graded exercises whereby a pupil's particular difficulty may be located. The usual type of examination does not satisfy this need. Standard tests, when properly devised for the purpose, may be made a great help in analyzing difficulties and prescribing remedies.

Scientific measuring instruments are needed in chemistry as

aids to supervision. General aims for secondary schools have been set up by the Commission on the Reorganization of Secondary Education[10] and these have been made more specific for natural science in a second report.[11] A supervisor needs to know if these objectives are being approached or if the teacher has some less well defined and less essential goals. This is difficult, if not impossible, to determine by occasional visits to the class or by conversations with the teacher. Answers may be secured, however, through the aid of appropriate tests designed to reveal the extent to which the aims are being realized. The supervisor also needs to know if the class is being over-taught in any phase of the subject and under-taught in others. Because of his particular interest in some phase of a subject a teacher may over-stress the topics relating to that part to the neglect of other divisions of the subject. A standard test, with norms gathered from a large number of cases distributed over a wide area, points out the general, country-wide tendency from which the average teacher probably should not depart without some very good reason. Furthermore, the supervisor has to compare the work of teachers. If he may know with a fair degree of precision the status of each group at the beginning and again at the end of the year, he will be able to compare the progress of the groups, and will have a basis for a fair comparison of the efficiency of the teachers.

Standard tests may be of considerable service to an administator in curriculum building. They may furnish data to help answer questions that demand accurate knowledge of the results of teaching under particular conditions. Some of the sorts of questions that standard tests will help to answer are these: How early in the curriculum may chemistry be introduced with the expectation of having it make a worthwhile contribution to the experience of the student? Should there be a prerequisite requirement of mathematics for the study of chemistry? What is the best sequence for physical and chemical science?

Finally, standard tests may be used by the teacher as models of a better kind of test than the usual essay type that has been so long in vogue.

The making of examinations for testing purposes . . . is a problem for experts in educational measurements. It is not

[10]Cardinal Principles of Secondary Education, U. S. Department of the Interior, Bureau of Education, Bulletin, 1918, No. 35, pp. 10, 11.

[11]Reorganization of Science in Secondary Schools, U. S. Department of the Interior, Bureau of Education, Bulletin, 1920, No. 26, pp. 12-14, 36-37.

a function that can properly be performed by a group of ever so capable teachers . . . unless they are familiar with the technique of test construction.[12]

It will be profitable, however, for teachers to become familiar with some of the fundamental ideas underlying this technique in order that they may supplement their usual essay examinations with these newer forms. For we must remember that they provoke a greater interest in students, that they cover a large amount of ground in a shorter time, that they are easily and quickly corrected, and that they are entirely objective so that results of different classes and of different years may be compared with some degree of assurance that the same things are under scrutiny.

Sufficient evidence has been presented in this article to substantiate the assertion that our inherited methods for determining achievement in chemistry are crude and unsatisfactory. The newer tests, scientifically constructed and standardized, are suggested as a better method of securing meaningful records of accomplishment. In addition, among other uses, they may be employed by teachers in determining the profitable content of a course, evaluating methods of teaching, and in measuring the results of instruction. Furthermore, they may be used by supervisors in judging the efficiency of teachers, and by administrators in arranging the curriculum. Probably no one test will serve all the purposes suggested in this article. Some of the needed varieties of standard tests for chemistry will be mentioned in a succeeding paper.

COD LIVER OIL MAKES COWS GIVE BETTER MILK.

Cod liver oil is not only good for growing children, it is good for cows and pigs. English scientists have found it to be valuable cattle food. More than that, it provides cows with the essential vitamin A which then appears in the milk, keeping up the vitamin content when, as in winter, it is not available from natural sources.

It has been found that cows fed on cod liver oil do not show an increase of fat in their milk, the milk is no richer in cream, but the amount of vitamin is greatly increased. Cows normally get their supply of vitamin A from fresh grass, but it is absent in dried hay and in grain feeds so that the milk in winter is deficient in this respect and children fed this milk do not get from it the vitamins so necessary to their growth.

Cod liver oil feeding solves this difficulty and makes possible the production of milk richer in vitamin at all seasons. Only a small amount of oil is needed, two ounces a day being enough for a cow. Even in larger doses no fishy or oily taste is given the milk.—[*Science Service.*

[12]Kruse, op. cit., p. 520.

ON RAINY DAYS.

By Alfreda Raster,
Nacogdoches, Texas.

"Let's write a letter," said Billie looking wistfully at the rain outside. What did grown ups always want a boy to go to school for? And when there was a perfectly wonderful storm outside, why did he have to stay inside? The girls were terrible tattle tales. If he were a girl he would let the boys play hookey whenever they wanted; he would not tell on them. What luck.

"There is no way of writing a letter for commercial geography," stated the teacher knowingly. She looked dismally at the class before her. It was her best class. The pupils had started out with enthusiasm, but to-day it was almost unmanageable. Some of the big boys were more or less attentive, but the smaller ones who wanted to be out in the thunderstorm were unconsciously scuffling their feet and fidgeting. The girls were politely attentive, but when the big crashes came, some of them screamed, while others giggled at those who screamed, forgetting that they, too, were frightened. Had the teacher been less conservative, she probably would have scolded, though in that case her results would have been fair temporarily, but disastrous in the end.

Billie wondered when the hour of imprisonment would be up—so did the teacher, but she labelled it drudgery instead of imprisonment. The disorder was too apparent to be merely imaginary. Of course, it was easy to blame the weather, but blaming the weather and teaching the children were two different stories. The principal had increased the distress of the situation by previously telling her to "Pep up the class—step on the gas—put a spark of life into the work." Something had to be done quickly, for any minute he might enter the room.

But what could she do?

"Let's write a letter," ran through her mind as she conducted the lesson mechanically. She thought the expression over and over again, "Let's write a letter."

Suddenly the strained expression on her face vanished, and her eyes sparkled. She quickly brought the topic under discussion to a close.

"You may supply yourselves with a sheet of paper and a pencil," she said simply. Billie obeyed promptly but reluctantly, as did the rest of the class. What new kind of torture was the teacher going to inflict now? What was the lesson about anyway? Was this going to be a test? There was no time now to

look at the lesson. Why had he not studied before? Why could not a person day dream in peace? What was the question?

But the teacher continued: "You are sitting on the stump of a gnarled rubber tree in the heart of a great Mexican jungle." Since the pupils looked about them for the forest, the teacher informed them that they were to make believe they were in the forest, "just for the fun of it." That suited every one, even Billie, so she went on: "There is a native guide with you whose friend, Sambo, is going back to civilization in twenty minutes, and if you finish a letter in time, he will mail it for you. Your problem is to write the letter, describing the forest and your guide. You may also tell your friend other interesting things about the jungle. Your friend might be interested in buying land in your region, or in coming down there on his vacation, or in building a home there. You may advise your friend in these matters."

"Who shall we write the letter to?" asked Billie, who was the only one who was not writing.

"You may write it to some one you know here, or you may make up a person to whom you would like to write."

"Are there animals in the Mexican jungles?" asked Billie, again interrupting the otherwise silent room. But the teacher did not need to answer since the whole class involuntarily murmured the affirmative.

"I'm going to write about the animals," he said as he joined the rest of the class who had become engrossed in writing the products of their youthful imaginations. At the end of the twenty minutes the papers were read. Most of the girls told about the life of camping, while the majority of boys wrote about the animals. Three-quarters of the chapter on *Mexico* in the text described the forest, so that the writing of the letters was economical educationally.

In no time at all, it seemed, the bell rang. "Jumping jellyfish," he exclaimed, "What did the bell ring for anyway?"

To prepare boys and girls for positions in department stores, with opportunities for advancement, the London county council, in co-operation with an association of merchants, has established a school of training in retail distribution. The main work of the school is to give the students a thorough understanding of some type of merchandise, such as furnishings or textiles, and to train them to acquire knowledge for themselves by the use of such sources as textbooks, magazines, trade exhibitions, museums, and art galleries. Salesmanship, history and geography of commerce and color and design are included in the course.—[School Life.

ARITHMETIC IN THE JUNIOR HIGH SCHOOL[1]

By Lewis W. Colwell
Principal of the Cleveland School, Chicago, Ill.

The curriculum of the Junior High School must be determined on the one hand by the needs of a developing civilization and on the other by the nature and capacities of developing youth. These two criteria of worth are by no means opposed to each other. They constitute no bifurcated demand. They set up no dilemmas. For every child is born into organized society on the one hand and becomes a duly constituted member thereof while on the other hand he possesses a social nature that fits him into the world's work just in the measure that he finds himself. It is perhaps not far afield to say that all friction due to anti-socialistic tendencies is a maladjustment of individuals who have not discovered what they are good for. To select a school curriculum then, we must study the problems that civilization is solving and the work by which society maintains itself with a view of discovering the appeals that training can make to the capacities and tastes of a growing and expanding life.

Now when we examine industry we find it full of quantitative problems without the solution of which at every step of the way, no satisfactory progress is possible. Economies of production, of exchange, of construction, call for constant investigation and calculation. To reveal some of these data to the inquiring mind of youth is to enlist their instant interest and to prepare them for perseverance and endurance even though the solutions demanded entail protracted effort and sustained attention. Young people are just naturally interested in whatever makes the wheels go round and will spend themselves eagerly in the effort to know and to control dynamic things.

The traditional content of the seventh, eighth and ninth grade textbooks is notoriously unfit for adolescents in some important respects, among which are the inclusion of material foreign to their interests and the introduction of extended and complicated calculations in order to make problems different from and more difficult than

[1] Read before the meeting of the Central Association of Science and Mathematics Teachers, Chicago, November 27, 1924.

those of the lower grades. Much of the work for the seventh and eighth grades has been cast in the same mold as that of the lower grades. It differs only in degree and dreary useless complications.

Pupils leaving sixth grade have been taught the elementary processes with integers; they have some knowledge of common fractions; they have been taught a little regarding decimals. To continue to ring these stale changes through seventh and eighth grades is threshing over old straw. Furthermore the introduction of extended and complicated business practice under the pretense of teaching practical applications of percentage corresponds to no felt need. If pupils do not become apathetic or rebellious it is because they have had all initiative smothered and have learned to plod unwillingly and unwittingly but obediently along the profitless way.

Nor is the sin against the childhood any less in the usual ninth grade algebra. Pupils are plunged into abstractions that are not based upon experience and insight, so the floundering increases and the mortality rate of algebra classes is so high as to desere the name the slaughter of the innocents.

No, seventh grade pupils deserve a better fate than the type of mathematics usually imposed upon them. Nature and industry are full of interesting problems making a quantitative appeal. They move through a world full of the mechanical and see material construction on every hand. They behold forces everywhere operating. Something or somebody is constantly arriving or departing. Reduced to their simplest terms, the problems that arise in this field are questions of space and time and motion. It is therefore high time when pupils reach the seventh grade that they be led to investigate the spatial elements of this busy, bustling, interesting world in a new and definite way. It is now time to acquaint pupils with some of the elements of precision in measuring, to train their powers to estimate distances and spaces, and in a word to train them in *quantitative appreciation.* Work with numbers cannot develop the mathematical sense; only the hand and eye training that comes from manipulation of spatial forms, solids, surfaces, lines and points can furnish the basal experiences upon which the significance of

mathematical value can rest. Numerical evaluation gets its meaning where and if used as subordinate to these more primary percepts.

Then let us give seventh grade pupils mathematical instruments. Let them learn the use of straight-edge and compasses and protractors and linear scales including the metric linear scale—not by studying about them but by using them as tools of investigation.

This would mean of course giving seventh grade pupils exercise, in actual measuring with linear scales, using not only the common units, yard, foot and inch, but the rod also. A clear concept of the mile may be reached by exercise, in actual measuring with linear scales, using by drawings made to scale. Thus the conception of distance should be enlarged and elaborated on.

Pupils should be taught how to draw to scale after discovering the need for drawing to scale in platting or mapping first familiar near-at-hand areas larger than the paper on which the drawings are made and later by representing larger areas and remoter distances. This will introduce some real and significant calculation with numbers having both intrinsic interest and immediate application. The interpretation of blue prints in suggested. The application to geography and varying scales of maps is evident. In geography, especially, the educated sense of distance is essential.

In mapping and planning there are three characteristic problems that appear. (a) If we are drawing to scale, we have given distances and a given scale. Any given exercise then is a series of constructions dependent upon calculating the required line segments from the given data, viz., the actual given line and the given scale. Representing these elements by L, s and l, we have given each time L and s to find l. Each operation is observed to be multiplying a given distance value by a given ratio or scale, hence we may generalize the operation by writing the formula $l=Ls$.

(b) If we are using a map and a given scale of miles to find the actual distance between two cities, we have given l and s to find L. In this case we must divide the measured distance on the map, l by the ratio s (or multiply it by the reciprocal of s). Generalizing we write $L=l/s$.

This is division by partition. (A term value divided by a ratio.)

(c) A third problem may arise. Having a given plat or map and the actual thing or distance represented, we may desire to find the scale. In such case we must divide the platted distance l by the actual distance L. This time the formula becomes $s=l\div L$.

These three formulas with appropriate changes in letters will be recognized as typical of the three so-called cases of percentage. Substituting P, R and B for L, l and s the formulas become (a) $P=BR$, (b) $R=P\div B$, (c) $B=P\div R$.

Again, if in any multiplication problem we call the product P, the multiplicand M, and the multiplier m, we have (a) $P=Mm$, (b) $m=P\div M$, (c) $M=P\div m$.

If in any division problem, we call the dividend D, the divisor d and the quotient q, the formulas may reappear as (a) $D=dq$, (b) $q=D/d$, (c) $d=D/q$.

A study in angles and triangles requires the compasses and protractor. The properties of right, acute and obtuse angles, of 45° angles, 60° angles are soon discovered. The method of dividing a circumference into sixths, into twelfths, into fourths and the consequences that flow from these constructions, the bisection of a line, the construction of a line perpendicular to or parallel to another are exerimented with. In such a mathematical laboratory, experiment is followed by application and generalization and a real sense of mathematical values begins to find lodgment in pupils' heads.

Thus numerical calculation falls into its legitimate place as an evaluation of quantitative relationship, so that laborious ciphering which has hitherto been a forbidding and unwelcome taskmaster, takes the role of ministering to a felt need. Hence pupils gladly endure necessary drills because of the help they secure from the additional skill they acquire.

Pupils of the seventh grade are usually far from skillful with figures and facile in numerical operations. They need little additional instruction in technique, perhaps, if the work of the preceding grades has been well done, but they do need loads of practice in direct and simple calculation, like ordinary adding of columns. They need gentle

leading in the snares of subtraction, in multiplying, and in long division. Measured graded daily practice, progressive in character, is needed in most if not all classes. This should be abstract in character and emphasis should be laid on accuracy, though facility and promptness should also be encouraged. Greater familiarity with common fractions and with the handling of decimals is also desirable and should be provided.

In the advanced seventh grade, there is a fine opportunity to apply drawing to scale to the making of simple graphs, line graphs, and bar graphs principally, and to open up the mysteries of percentage through graphing and diagramming. The study of percentage should return to whatever knowledge of decimals may have been previously acquired and should seek to illustrate and extend the same. Multiplication by pure decimal multipliers needs careful attention. The *product* of such a multiplication should be sensed as of less value than the *multiplicand*. This is essentially the first case of percentage and may be the basis for instruction in the same.

Division of one number by another resulting in a pure decimal quotient leads up to the so-called second case of percentage. The observation that division of whole numbers is not limited to cases where the divisor is less than the dividend and that the quotient need not be greater than unity and that any quotient is really the expressed ratio of dividend to divisor may well be noted. This is the second typical problem, "Given two terms, what is their per cent relation?" Another form of this problem is "What part of a given number is another given number?" Such examples throw light on this case of percentage. This should be seen as a measuring operation involving a standard or *measuring* number, a *measured* number and a *resultant of* measuring, or ratio, which ratio or quotient in such cases is most frequently less than one.

Division of a whole number by a proper fraction or a pure decimal typifies the third so-called case of percentage. Previous to the experiences that arise out of such percentage problems the solution of such division problems has probably had only a superficial, formal meaning. Finding the number of which a given number is a given part is the significance of such division. Finding a re-

quired number when a given part of it is given, may be done by dividing the given part by the given fraction (or multiplying by the reciprocal of the given fraction). This so-called indirect problem is not easy to grasp and is not stressed by some teachers, but it seems important to me because it is so significant. It is really division by partition. The last previous type or case II is division by measure.

In the advanced seventh grade, daily practice with fundamental operations, fractions, and decimals, should be continued as in the beginning seventh grade.

For the eighth grade, I would suggest, first, a return to the experimental, constructive exploration of spatial form. First, let such pupils study the kinds and properties of triangles and practice the various constructions and mensurations involved, then let them proceed to study quadrilaterals in the same fashion and perhaps to make some of the regular polygons and calculate the interior angles of the same. This will lead naturally and easily to the study of parallels, transversals and perpendiculars. The mensuration of the circle and of cylinder might follow, but it seems to me the mensuration of the pyramid, cone, and sphere should be postponed for more advanced work.

By the time the advanced eighth grade is reached, some simple algebra might be systematized by gathering up formulas developed and used in the mensuration work already accomplished. If the convenience of letters as symbols of generalized or abstract numerical values is emphasized, then from this experience it should be an easy step to sense the convenience of representing any undetermined number by a letter and to translate the conditions of a simple algebraic problem from ordinary verbal language to the equational or mathematical form. The solution of such equations by a series of perfectly evident easily taken steps follows and thus without undue effort the algebraic "pons asinorum" has been crossed. These derived equations I hold should be reached directly and intuitively rather than by the time-honored but stale device of introducting axioms and laborious expositions of feats of balancing, of adding or subtracting equals. This

is usually so formal and far-fetched, at this stage of the pupils' mathmematical evolution, as to obscure direct relations that are easily seen. It is likely to substitute a sort of juggling for direct insight. Such contrivances may or may not be of some value when more advanced equations are reached but the purpose here is not so much to develop manipulative skill as to produce real insight into mathematical situations.

After pupils learn to translate from common language to equation form many simple algebraic problems and to reach an algebraic solution of such problems, some practice for them is legitimate that will fix the knowledge which has been acquired and will stress simple manipulative skill. Such forms as the following are recommended.

$3n=12$	$6x-2=4x+14$	$x/5=8$
$36=4b$	$140=8x+4$	$2/3x=16$
$3n+5=14$	$20m=40+12m$	$3x/4=2x/3=2$
$7m-8=43$	$8n+4=6n+10$	
$6x=15-3x$	$13+x=450$	

Verification of solutions by substituting in the first equation of a solution the value found in the last will lead naturally and easily to evaluation. The use of formulas in mensuration is really evaluation. So is the use of the percentage formula $P=RB$, the interest formula $I=prt$, the cost formula $C+pn$, the selling price formulas, $s=c+g$ and $s=c-1$. This is perhaps as far in this direction as an eighth grade class should go.

A study of similarity of triangles and of other polygons and of solids develops the subject of ratio in a clear and graphic way. From the study of ratio and proportion as applied to the geometrical elements, further study of the subject as applied to other quantities, time, capacity, weight, money value, etc., is easily made and because of its analogy to the preceding study is easily understood.

Simple studies in indirect or calculated measurement, by means of similar triangles, heights of buildings, widths of streams, can be introduced here. Heights of trees or of poles may be calculated by comparing the shadow with a shadow cast by an object whose height is known, or it can be done by an observation on the ground at a given distance from the pole, which observation determines the angle of elevation and includes a staff of a given length

with its top in the line of observation. Once more height can be determined by platting the given distance of the observer from the fact of the object measured constructing the angle of observation at one end and the represented height at the other end and then measuring the platted height that results. This can be reduced to actual height by means of the scale used.

All this is within the capacity of eighth grade pupils that have had the seventh grade course here laid down. It is suggestive, illuminating, deals with familiar elements of pupils' everyday experiences, and is much more interesting than solving problems in bank discount or the usual problems of a mercantile type which most text-books spawn in such tiresome abundance.

A study of the relation of the hypothenuse of the right triangle to its other two sides may introduce not only the triangle whose sides are in the ratio of 4, 5, 6, but others with the ratio 5, 12, 13, or the ratio 7, 24, 25. Such a study with accompanying drawings to scale not only avoids the square root of imperfect squares which may be postponed to a later treatment, but it also motivates the topic of square root and furnishes an introduction to it that is clear, definite, and full of suggestion.

Since some business practice will be insisted on and since it has practical value, some attention may properly be given it. But it should be remembered that such practice is not properly mathematics, useful though it may be and is. Keeping accounts and the making of budgets are worth some time and attention. Likewise the topic of banking and familiarity with the methods of depositing, withdrawing, and borrowing or investing money and calculation of interest are commercial topics of value and worthy of attention.

Daily practice in calculation with progressive exercises designed to increase accuracy and facility, recognition of short processes of calculation and readiness as well as accuracy should be insisted on unceasingly.

The foregoing sketch does not attempt an outline for ninth grade because the ninth grade course, though dealing with generalized mathematics, will emphasize more particularly the algebraic phase of the subject. That topic is assigned to another person.

COMMENT ON ARTICLE BY J. M. HUGHES.

By Dr. G. W. Stewart,

University of Iowa, Iowa City.

The sensible article by Professor J. M. Hughes, in the December, 1924 number, on "Shall we mathematize or demathematize high school physics?" calls to mind what I believe to be a fact; namely, there may be some hostility to the demathematization, but it does not represent the opinion of physicists generally.

No college teacher of physics would admit that the value of his course in physics for engineers can be measured by problems even simpler than those studied in course but given a few months after the conclusion of that course. Neither would a highly trained physicist admit that the value of his graduate study in mathematics could be measured by his skill in this field as measured by relatively simple questions even a year after his graduation. If such is our faith in the inadequacy of problems to test the abiding value of even "technical" courses how much less should we be willing to see this method used to test the value of high school physics!

College physicists are interested in the adequate preparation of high school teachers and are willing to accept the latter's judgment provided these teachers attempt to adjust the subject matter to the *needs* of high school students rather than to what they think these students *ought to need.*

G. W. STEWART.

THE UNIVERSITY OF CHICAGO AND RESEARCH

In discussing the relation of the University to research President Ernest DeWitt Burton, of the University of Chicago, said in his recent Convocation Statement:

"In the promotion of research a university has its own task to perform which cannot be accomplished by either the commercial organization or the special research institute or foundation. To an extent that neither of these others does, the University represents the whole circle of knowledge, and therefore the interrelations of department with department, of biology with medicine and with sociology, of law with political science, and of history and philosophy with theology. It brings together in daily contact the workers of these various fields and helps to protect them from the narrowness of vision into which extreme specialism tends to lead.

"It tends continually to replenish the race of investigators, and guarantees that the work will go on. It is probably safe to say that over 90 per cent of the men who man, not only our university laboratories, but also those of the research institutes and the commercial organizations, are themselves the product of the universities."

GRAFTED POTATOES GROW LIKE FRUIT.

Grafting, a procedure quite common in tree culture, has been applied to vegetables and flowers by a French botanist who has by this method increased the size and yield, created new species, prolonged the life of plants and intensified the perfume of flowers.

Prof. Lucien Daniel of the University of Rennes has performed grafting operations on cabbage, lettuce, beans, potatoes, tomatoes and various flowers. Other botanists who have examined his results concede that the fantastic experiments made by Prof. Daniel hold much practical promise for the market gardener.

One of the first attempts made by Prof. Daniel was to graft the black Belgian bean on a large white Soissons bean. From this combination plant he obtained seeds of an entirely new variety of beans which has remained fixed.

He took a bitter variety of cabbage unfit for food but which resists frosts and grafted on it a variety that has a good flavor but succumbs easily to cold. The seeds of the hybrid yielded a new variety that tastes good and resists cold.

Some of his most sensational grafts were made on the family Solanaceae to which belong such useful plants as potatoes, tomatoes, tobacco, and egg plant. He grafted sections of egg plant on tomato vines. First the grafts produced the regular ovoid egg plant fruit and later on the same branch yielded other fruit resembling that of tomatoes. Finally a true hybrid, round in shape, was obtained.

Prof. Daniel has also grafted tomato branches and belladonna on potato vines and potato stems on egg plants and tomato vines. Potatoes, of course, are simple swollen stems or tubers which develop underground. He was curious as to what would happen when he grafted a potato stem on another plant. Would tubers continue to be produced? Yes, they were, but not underground. Large beautiful tubers hung from the branches like fruit.

These aerial tubers when planted yielded a new kind of underground potatoes which were more resistant and developed more quickly than those of which they were the offspring.

A still more fantastic discovery was the finding, among these second-generation hybrids, of three plants which bore both aerial and subterranean tubers at the same time. These tuebrs being harvested and planted yielded a staple new variety rather late in developing but delicious in flavor, extra large in size and very hardy.

One of the most recent experiments is the double grafting of belladon- and tomato. Upon a tomato stem, a sprig of belladonna was grafted and then upon the latter again a tomato stem. It was found that the belladonna plant had by this operation lost its property of producing atropin poison which is normally found in all parts of the belladonna plant.

A series of experiments with chrysanthemums and other flowers showed that grafting caused flowers in many instances to yield a more pungent perfume, a fact of great importance to the perfume manufacturers of South France. Numerous trials with other plants are now being made of which the results have not yet been announced.—*Science Service.*

One of every ten members of the faculty of the Pennsylvania State College is devoting virtually his entire time to research work. Thirty men and one woman are investigating problems on agricultural and industrial conditions in Pennsylvania.

UNITED STATES PUBLICATION.

Publications and other materials of all Federal Departments useful to teachers are listed for the first time in a bulletin just issued by the Bureau of Education of the Department of the Interior.

The materials listed include bulletins, leaflets, circulars, periodicals, maps, charts, mounted exhibits, models, stereopticon slides, and moving picture films. This listing by sources of the wealth of material readily available through the Federal Government Departments will be very helpful to the educational world as few know the nature of the available material or the method of obtaining it. The bulletin is freely illustrated, reproducing types of the material available. Persons desiring the bulletin should address the Commissioner of Education, Department of the Interior, Washington, D. C., asking for Bulletin 1924, No. 23.

AN ALCOHOL BURNER FOR THE LABORATORY.

By B. S. Garvey,

Boone University, Wuchang, China

For schools so situated that gas cannot be obtained for the chemical laboratory, the alcohol burner shown in the accompanying diagram is a fairly satisfactory substitute. The burners can be made quite cheaply either of brass or of galvanized iron.

It consists merely of a round cup with an air pipe running up through the middle. The inner cover is to keep the alcohol from splashing. The outer cover is tight-fitting and has a hole large enough to fit around the air pipe and still leave room for an ordinary lamp wick. The wick is doubled up and drawn up around the air pipe. (A round wick would be more convenient.) After lighting the wick the chimney, a cylinder with two slits in the bottom, is placed over the flame. When not in use the wick should be covered to prevent evaporation.

The temperature can be varied considerably by changing the amount of wick pulled out and by varying the air blast.

Where there is no air pressure system these burners can be used with satisfaction by blowing through a rubber tube with a glass mouth piece. However, an inexpensive system can be installed by using a blacksmiths' bellows and a water pressure reservoir, or better by a rotary bellows, preferably electric. The chief expense of such a system is the pipe.

These burners, even without the air pressure system, have proved quite satisfactory for work in general chemistry.

UNITED STATES PUBLICATION.

Publications and other materials of all Federal Departments useful to teachers are listed for the first time in a bulletin just issued by the Bureau of Education of the Department of the Interior.

The materials listed include bulletins, leaflets, circulars, periodicals, maps, charts, mounted exhibits, models, steroptican slides, and moving picture films. This listing by sources of the wealth of material readily available through the Federal Government Departments will be very helpful to the educational world as few know the nature of the available material or the method of obtaining it. The bulletin is freely illustrated, reproducing types of the material available. Persons desiring the bulletin should address the Commissioner of Education, Department of the Interior, Washington, D. C., asking for Bulletin 1924, No. 23.

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS.

One of the most successful years in the history of the Central Association of Science and Mathematics Teachers closed with the annual convention held November 28th and 29th at the Nicholas Senn High School, Chicago, Ill. The program began with a selection by the Senn High School Band. President Holtzman then introduced Assistant Superintendent William J. Bogan of the Chicago Schools who welcomed the visiting teachers. His chief message consisted in a warning that theories discussed and approved must be tried out in the classroom or the work of the Association will be without value.

Miss E. Marie Gugle, Assistant Superintendent of Schools, Columbus, Ohio, read an interesting and instructive paper on Mathematics in the Junior and Senior High Schools. She also placed on exhibition samples of the mathematics work from the Columbus schools.

The second paper, The Sequence of Science in Junior and Senior High Schools, was read by Professor George W. Hunter, Knox College, Galesburg, Ill.

The last address of the morning was delivered by Dr. E. E. Slosson, Director Science Service, Washington, D. C., on laying the Foundations of Scientific Education.

These papers will be printed in School Science and Mathematics for the benefit of those who could not attend the meeting.

The afternoon was devoted to section meetings, followed by demonstrations of apparatus by the companies dealing in scientific apparatus, maps, books, etc.

The annual dinner served in the Senn Dining Room was attended by about one hundred fifty members hailing from New York to Iowa and from Missouri and Tennessee to Minnesota. The after-dinner program was presided over by Vice-President Kelsey of St. Louis.

After dinner came the real treat of the convention. Dr. Fay-Cooper Cole of the University of Chicago, Leader of the Field Museum Expedition to Sumatra and the Malay Peninsula gave his wonderful lecture "Where East Meets West" illustrated by a series of slides. It is a most interesting story of hardship and adventure in the interest of science, modestly told.

ANNUAL BUSINESS MEETING.

Senn Auditorium, Saturday, 9:00 A. M.

President Holtzman called the meeting to order and the following reports were given:

Annual report of the Treasurer, W. G. Gingery, Shortridge High School, Indianapolis, Ind. The financial condition of the Association is very satisfactory.

Report of the Auditing Committee. In the absence of the chairman, Frank B. Wade, Joel W. Hadley reported that the accounts were correct and the treasurer's books approved by the committee.

Report of the Advertising Manager, Charles Leckrone, Lake View High School, Chicago. The year-book contains sixty-six ads, twelve of which are one-half page each and fifty-four a full page each. This will approximate $900.00.

Report of the Membership Committee. Miss Mary B. Pardee reported that 4500 letters had been sent out to teachers in high schools and 250 letters to college teachers. One hundred sixteen new members have been added to the roll and many more have declared their intentions to become members.

Report of the Necrology Committee. Frederick W. Plapp, Schurz High School, Chicago, reported that his committee had been unable to learn of the death of any member during the year.

Report of the Resolutions Committee. Colonel Harry D. Abells' report is printed in full elsewhere.

These reports were approved as read and the secretary was directed to send letters of appreciation to all non-members who contributed to the program.

Mr. W. F. Roecker reported nominations as follows: President, Professor Elliott R. Downing, University of Chicago; Vice-President, Frank I. Goodell, Des Moines, Iowa; Secretary, Miss Ada Weckel, Oak Park, Illinois; Corresponding Secretary, Miss S. Aleta McEvoy, Rockford, Ill.; Assistant Treasurer, Ira C. Davis, Madison, Wisconsin.

This report was approved and the secretary was instructed to cast the unanimous ballot for all nominees.

Dr. Downing was then called upon and made a brief address.

Meeting adjourned at 10:00 A. M.

Glen W. Warner, Secretary.

REPORT OF THE RESOLUTION COMMITTEE.

Resolved: That the Central Association of Science and Mathematics Teachers extend to the Board of Education of Chicago its hearty thanks for the use of the Nicholas Senn High School for its twenty-fourth meeting.

Resolved: That the Central Association express its appreciation to the members of the faculty and students of the Senn High School for their generous hospitality and entertainment.

Resolved: That the Central Association voice its gratitude to the educators who presented papers at our general and section meetings: and that the Secretary send a letter of appreciation to such of these men and women as are not members of the Association.

Resolved: That the Central Association of Science and Mathematics record its thanks for the great service its general and section officers; the members of the advertising and membership committees have rendered the Association. Particular mention is made of the work of its Secretary who for four years has given his effort and time in a most unselfish and efficient manner.

Resolved: That the Central Association heartily approves the investigations which the Association has already carried out and commends further investigations as a procedure for straight line progress in the teaching of science and mathematics.

Resolved: That the Central Association continue to study the reorganization of the courses in Science and Mathematics as demanded by the development of the Junior High School.

Whereas it is generally recognized by educators that training in learning is more important than the knowledge acquired be it resolved that greater emphasis be placed in the section meetings upon the methods and modes of teaching than upon the selection of the subject matter.

HARRY D. ABELLS,
WALTER W. HART,
HERBERT R. SMITH.

MINUTES OF MATHEMATICS SECTION C. A. S. & M. T.

The Mathematics Section of the Central Association of Science and Mathematics Teachers held two meetings Friday afternoon and Saturday morning, November 28 and 29, 1924.

Friday Afternoon Meeting.

The meeting was called to order by the chairman, Mr. A. M. Allison, of Lake View High School, Chicago, Illinois, who appointed as nominating committee: Mr. Kavanaugh of Lewis Institute, Mr. Kitch of Oak Park and Miss Hopewell of Hyde Park.

"The Value of Verbal Problems in Algebra" was the first topic to be considered and the discussion of it was opened by Dr. J. M. Kinney of Crane Junior College, Chicago.

Dr. Kinney spoke of the origin of verbal problems in ancient times, when apparently they had no serious purpose but were proposed merely as puzzles as for example: the heap problem of Ahmes. The speaker gave four reasons for their employment at the present time:

(1) To give a concrete application of an abstract theory.

(2) To develop the ability to translate a quantitative relationship, expressed in words, into the symbolic language of algebra.

(3) To develop the ability to think.

(4) To develop the ability to solve the problems of a quantitative nature that may arise in the various fields of human endeavor.

Dr. Kinney said that a verbal problem as well as any other problem should raise a genuine mathematical question and closed his paper by giving three "exhibits" of verbal problems. Those in exhibit A he felt did more harm than good by giving a mistaken notion as to the function of mathematics, as in every case the proposer of the problem knew the answer. Those in exhibit B raised genuine questions and through them the pupil would realize that mathematics is a useful instrument of investigation but, because they were framed for the purpose of securing a particular numerical solution, he felt they were not so valuable as those in exhibit C which gave rise to a general solution and displayed relationship existing between variables.

Mr. C. M. Austin of Oak Park High School was the next to speak. He defended the verbal problem because of the training in reasoning which it affords the pupil. He said that no other subject in the first year of High School at the same time furnishes a problem and method of solving, and that since most people agree that the value of the problem lies in framing the equation that it does not matter if the problem is artificial.

A very interesting discussion followed in which the following participated: Mr. Hester of Lane Technical High School; Mr. C. E. Comstock of Bradley Polytechnical Institute, Peoria; Miss Mable Sykes of Bowen High School; Mr. W. C. Beck of Iowa City, Iowa; and Mr. W. W. Hart of Madison.

The next topic on the program, "Factors in the Pupil's Reaction to Mathematics" was discussed by Mr. Olice Winter of Harrison Technical High School, Chicago. Mr. Winter said that there were three factors to be considered: the pupil, the teacher and the type of subject matter. In considering the first factor, the pupil, he said that there are all kinds of pupils in high school today. There are three and one-half times as many going to high school now as in 1890 and with this influx of those of lower intelligence it is impossible to require the kind of algebra we used to. It is the problem of the teacher both to adapt the subject to the pupil and also to interest him. The difficulty is to find the type of mathematics suited to those who come to us.

Mr. Miller of Chicago Normal, Mr. Schreiber of Maywood and others took part in the discussion which followed.

"Arithmetic in the Junior High School" was the subject of a very interesting paper by Mr. Lewis W. Colwell, Principal of the Cleveland School, Chicago, in which he said that the work of the seventh and eighth grades should not be cast in the same mold as that of the lower grades. He said that in these grades the pupil should become acquainted with spatial ideas; that he should be trained in quantitative appreciation; that he should have exercises in actual measurement with linear scales of various sorts and that he should learn to recognize such distances as rod, mile etc.; that he should be taught to draw to scale. The pupil should learn to know angles as he sees them in every day life; he should learn to use protractors, compasses and T-squares. The speaker thought that the pupil would be much more interested in the construction of equilateral and 45° and 60° and 30° right triangles than in figuring bank discounts.

In the discussion that followed Mr. Schorling and Mr. Comstock emphasized the need of arithmetical computation.

The last topic of the afternoon's program—"Algebra in the Junior High School" was very ably discussed by Mr. Edgar C. Hinkle of Chicago Normal College.

Mr. Hart spoke briefly of the work of the steering committee and it was moved and seconded that this committee be continued.

Saturday Morning Meeting.

"A Study of the Factors of Success in First Year Algebra," Illustrated with Lantern Slides" was the subject of a very interesting paper by Mr. Edwin W. Schreiber of Proviso Township High School, Maywood, Ill. The paper was based on a study of the results of standardized tests in arithmetic, algebra and of mental ability as well as grades in first year algebra given to 160 pupils in eight different classes of first year algebra in the mathematics department of Proviso Township High School. Some of his conclusions were:

(1) The two most used arithmetic abilities,—addition and multiplication have relatively little to do with a pupil's algebraic ability or with his success in algebra as measured by semester marks.

(2) Our chief criterion in measuring a pupil's success in first year algebra is his ability to manipulate the machinery of algebra rather than his capacity to intelligently use this machinery.

(3) General intelligence is a substantial factor of success in first year algebra.

(4) Age is not a contributing factor to success in first year algebra.

(5) The time of day when the class recites is not a contributing factor to success in first year algebra.

(6) Success in deriving equations seems to be due in considerable measure to general intelligence.

(7) Pupils fail in first year algebra because of low intelligence.

"Geometry in the Junior High School" was next discussed by Mr. John T. Johnson of Chicago Normal College. Mr. Johnson had made a careful analysis of the space devoted to Geometry and Trigonometry in ten standard texts in Junior High School Mathematics published since 1917. His report and the discussion, which followed later seemed to indicate that demonstrative geometry should not be taught in the Junior High School.

The last paper of the morning was the report of an experiment with correlated mathematics in a large high school by Mr. Paul R. Pierce of Austin High School, Chicago. This experiment was started three years ago and has been found so stimulating that it is to be continued. Some of the findings were: that there should be continuity of fundamental topics: that each topic should be mastered before leaving it; that correlation enriches the mathematical course; that 9th grade work is especially favorable to correlation; that the problem of correlation is much more complicated for the tenth year in demonstrative geometry and that once demonstrative geometry is started it should not be interrupted.

Some of those taking part in the discussion which followed were Prof. E. D. Lytle of the University of Illinois; Mr. J. A. Nyberg of Hyde Park; Mr. E. W. Owen of Oak Park; Miss Emma Ackermann of Lockport, Ill.; and Mr. Hester of Lane Technical High School, Chicago.

Mr. Kitch read the report of the nominating committee which was as follows: for chairman, Mr. Raleigh Schorling of University High School, Ann Arbor, Mich.; for vice chairman, Mr. Everett W. Owen of Oak Park; for secretary, Miss A. Blanche Clark of Rockford High School, Rockford, Ill. The report was accepted and these officers elected. The meeting adjourned.

A. BLANCHE CLARK,
Secretary.

MINUTES OF THE CHEMISTRY SECTION, C. A. S. and M. T.

The meeting was called to order in room 36 of the Nicholas Senn High School, Chicago, by C. D. McLouth, Chairman. The room was crowded beyond its seating capacity, chairs being brought from other parts of the building.

Mr. Minor of the Minor Laboratories of Chicago gave a most interesting talk on the utilization of oat hulls as a by-product in the manufacture of rolled oats, for the commercial preparation of furfural. He gave the history of the industry, showing how the preparation of furfural and its uses had been worked out in the laboratory.

Professor B. S. Hopkins of the University of Illinois read a paper on "The Training of the High School Chemistry Teacher-Prospective and in Service." Professor Hopkins said that the teacher should be well informed both in subject matter and in method. For the prospective teacher there are only fifteen colleges and universities offering courses in the teaching of chemistry and the majority of these courses consist of only one period per week. The teacher in service should study the needs and interests of his community, should read informational and professional matter, should belong to the American Chemical Society and should associate with others in the same type of work.

A discussion of the paper was led by H. R. Smith, Lake View High School, Chicago. Mr. Smith urges that the smaller colleges should also offer courses in the teaching of chemistry. Much discussion followed. The following resolution offered by Mr. Smith was unanimously adopted:

Whereas the teaching of chemistry is a highly specialized profession which is becoming more intricate because of the increasing complexity of the science of chemistry; and

Whereas a successful teacher of Chemistry requires both a definite knowledge of the science and a definite training in its pedagogy, and

Whereas the universities and colleges are not now supplying graduates who know both the science and the pedagogy of chemistry, therefore be it

Resolved by the Central Association of Science and Mathematics Teachers in annual session at the Nicholas Senn High School, Chicago, that we urge strongly upon colleges and universities throughout the country the necessity of offering more adequate teachers' courses, the purpose of which will be to provide adequately trained teachers of chemistry.

Professor H. J. Schlessinger of the University of Chicago presented a paper on the "Relation of the Minimum High School Course to College Chemistry." Professor Schlessinger offers a beginning course to chemistry at the University to which only students having had a high school course are admitted. Repetition of subject matter presented in the high school course is often made not, however, in the spirit of criticism but in order to fix the principles more clearly in the minds of the pupils. The high school course should be presented largely from a descriptive point of view while the college course is characterized by generalization. The essentials of the high school course should be kept at minimum in order to give the teacher sufficient latitude to deal with topics of local importance.

Miss Agnes F. Jacques, Vocational High School, Minneapolis, spoke on Investigation of the Status of Chemistry in the High School of Minnesota Relative to:

a. The Percentage Taking Chemistry in High School Who Follow an Advanced Course in College.

b. The Trend Towards Differentiated Chemistry.

Miss Jacques showed by questionnaire that only 29% of the students who studied high school chemistry in Minnesota expected to study college chemistry. She thinks, therefore, that high school chemistry

should be differentiated. Especially does she urge this for girls so as to better fit them for their specific duties.

The chairman appointed the following nominating committee: C. A. Amick, J. O. Frank, H. M. Mess.

At the general meeting, the following day the report of the nominating committee was read and accepted.

The officers for the coming year are as follows:

Margery Stewart, chairman, New Trier Township High School, Kennilworth, Ill.

Sylvester Moore, vice chairman, Arsenal Technical High School, Indianapolis, Ind.

B. J. Chervenka, secretary, Cleveland High School, St. Louis, Mo.

SYLVESTER MOORE,
Secretary.

NEW ENGLAND ASSOCIATION OF CHEMISTRY TEACHERS

The annual meeting of the New England Association of Chemistry Teachers was held at Tufts College, Medford, Mass., on Saturday, November 15, 1924. The following officers were elected:

President, Leslie O. Johnson, New Haven, Conn.

Vice Pres. Prof. Herbert F. Davison, Brown University, Providence, R. I.

Secretary, John Card, English High School, Boston, Mass.

Ass't. Sec., Miss Octavia Chapin, Malden, Mass.

Treasurer, Alfred M. Butler, High School of Practical Arts, Boston,

Sixteen new members were elected bringing the total membership up to four hundred and twenty-five.

After a few words of welcome Prof. Frank W. Durkee, Head of the Department of Chemistry, Turfts College, demonstrated numerous interesting lecture table experiments.

Prof. Neil Gordon of the University of Maryland, Editor of the Journal of Chemical Education, was a guest of the Association and told of the efforts being made to organize associations of chemistry teachers in various parts of the country as well as other activities of the Division of Chemical Education of the A. C. S.

An address by Prof. David E. Worrall of Tufts College stressed the recent contributions of American scientists to organic chemistry.

In the afternoon about thirty-five members of the Association were guests of the college at the annual Tufts vs. University of Maine football game.

JOHN H. CARD.

IOWA SCIENCE TEACHERS.

The Chemistry Physics Section of the Iowa Association of Science Teachers met at West High School, Des Moines, Iowa, on November 6 with Professor Bartow, head of the Chemistry Department of the State University of Iowa in the chair. Following the Physics part of the program, Secretary Alexander Williams spoke of the Prize Essay Contest and suggested cooperation with the American Chemical Society in its educational program. In accordance with his suggestion, a cooperating committee was appointed, consisting of F. E. Goodell of West High School, Des Moines, as chairman and contributing editor to the Journal of Chemical Education, Professor F. E. Brown of Iowa State College and Frances Church of East High School, Des Moines.

Professor P. A. Bond, chairman of the committee appointed to investigate the teaching of Chemistry in Iowa reported. His report was based on that of the committee on Chemical Education of the A. C. S.

The reports from high school and college instructors show the numbers of the topics in the A. C. S. committee report in the order of importance. Only the first ten are given.

Order of Importance	1	2	3	4	5	6	7	8	9	10
High School	(1&2)		11	4	5	9	12	12	3	24
College	5	(12&4)		2	11	1	3	18	15	9

The committee made the following recommendations as minimum drill topics for high school chemistry:

A. Correct writing of symbols, formulae, and balancing of equations
B. Problems emphasizing weight relationships
C. Recognition of acids, bases and salts and a clear conception of these interrelations and reactions
D. Some knowledge of ionization as a phenomenon
E. Knowledge of gas laws
F. General knowledge of chemical phenomenology

An active campaign is planned to reach every teacher of Chemistry in the state for the purpose of promoting chemical education in Iowa.

We are hoping to have some interesting material to report a little later.

F. E. GOODELL.

SIGNIFICANT EXPERIMENTS IN HEREDITY.

By the Head of the Botanical Department of the University of Chicago.

After working for five years in an experimental garden at Fifty-eighth Street and Cottage Grove Avenue, Chicago, in cross-breeding corn and observing the slow growth and fruition of the stock he created, Professor John Merle Coulter, Head of the Department of Botany at the University of Chicago, has announced some of the significant results of his work, which constitute a contribution to the body of facts upholding the principle of evolution. Incidentally they furnish material for a seeming modification of the laws of heredity established many years ago by Gregor Mendel, the famous Austrian scientist.

What Dr. Coulter has done is to observe and then confirm by three "critical tests" mutations, or sudden changes in the hereditary capacity of a higher order of plant. To verify such mutations is to establish new confirmation of the doctrine of evolution, since changes of that sort, although often changes for the worse in an organism, are sometimes changes which enable the plant or animal to meet the requirements of life better.

Another phase of Professor Coulter's work has been to watch for indications that acquired characteristics are hereditary; that is, whether, for example, a certain plant disease acquired during the lifetime of a plant can be inherited by its descendants. His study has revealed no such indications. He has, in that degree, furnished evidence against inheritance of acquired characteristics. This has a bearing on human heredity, since the machinery of heredity in plants and animals, including human beings, is the same.

In his experiments, Dr. Coulter used only races of corn which had been carefully pedigreed, so that their hereditary capacities were already known. He bred red and white corn together and produced hybrids. In previous experiments ears of corn were produced on which three quarters of the grains were red and one quarter white, following precisely the Mendelian law, or a ratio of three to one. But Dr. Coulter discovered one race of corn 90 per cent red to 10 white, and still another that gave 33 per cent of white, a mutation of such a sort as to modify the time-honored Mendelian ratio.

PROBLEM DEPARTMENT.

CONDUCTED BY J. A. NYBERG,

Hyde Park High School, Chicago.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and solve problems here proposed. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to J. A. Nyberg, Hyde Park High School, Chicago.

LATE SOLUTIONS.

848. *Raymond Determan, Mason City Junior College, Iowa.*

SOLUTIONS OF PROBLEMS.

851. *Proposed by I. N. Warner, State Normal School, Platteville, Wis.*

A creamery employs a man to go out daily to collect cream from the farms. How many pounds of cream testing 35 per cent fat must the man gather each day in order to pay his daily wage of $3, considering that the same price is paid for butter-fat per pound as is received for the butter per pound, namely, 25 cents, and that the "over-run" is 18 per cent:

(a) When cost of manufacture is not considered?

(b) When cost of manufacture is 3 cents per pound for the finished butter?

The "over-run" means the gain in weight by way of salt, water, etc., in the process of making butter. Any given weight of fat, in this case for example, gives 118 per cent of its weight when finished as butter.

I. *Solved by J. Murray Barbour, Ardmore, Pa.*

(a) $.18\times\$.25 = \$.045$ gain per pound of fat.

$\$3.00\div\$.045 = 66\frac{2}{3}$ pounds of fat needed.

$$\frac{100}{35}\times\frac{200}{3} = 190+ \text{ lb. cream.}$$

(b) $1.18\times\$.03 = \$0.354$ cost of manufacturing, per lb. of fat.

$\$.045-\$.0354 = \$.0096$ net gain, per lb. of fat.

$\$3.00\div\$.0096 = 312.5$ lb. of fat needed.

$$\frac{100}{35}\times\frac{625}{2} = 893- \text{ lb. cream.}$$

II. *Solved by T. E. N. Eaton, Redlands, Cal.*

(a) Let x = no. of lb. of cream bought.

Then $.35x$ = no. of lb. of butter fat bought.

$.35x(25) = \$.0875x$ = price paid for butter fat.

But $.35x(1.18)$ = lbs. of butter sold,

and $.35x(1.18)\,(.25) = .10325x$ = selling price.

So the profit is $.10325x-.0875x = .01575x$.

By the condition, $.01575x = 3$. Hence $x = 190\ 10/21$ lbs.

(b) The overhead is $.35x(1.18)\,(.03) = .012390x$.

So the total cost $= .0875x+.01239x = .09989x$,

and profit is $.10325x-.09989x = .00336x$.

Then $.00336x = 3$ and $x = 892\ 6/7$ lbs. cream bought.

Also solved by *N. Barotz, New York City; J. F. Howard, San Antonio, Texas;* and *Howard Batson, Neil Reiser, Frances Simos, Siskiyou Union H. S., Yreka, Cal.*

852. *Proposed by D. L. MacKay, New York, N. Y.*

Show by an example that two *similar* triangles having two sides of one *equal* respectively to two sides of the other are not necessarily congruent.

Solved by Arthur H. Lord, Classical High School, Lynn, Mass.

Since the angles of the two triangles are respectively equal to each other, the triangles will fail to be congruent only in the case in which the equal sides are not corresponding ones. Two right triangles having the hypotenuse and leg of one equal to the two legs of the other will satisfy the required conditions if they can have an acute angle of one equal to an acute angle of the other; this is possible if there is an angle whose tangent equals its cosine.

Let $\tan x = \cos x$, and solve the equation. The equation is satisfied if $x = \text{arc sin } \frac{1}{2}(-1+\sqrt{5})$, or 38° 10′ 9″ approximately.

Therefore two right triangles can be constructed, each having an acute angle whose sine is $\frac{1}{2}(-1+\sqrt{5})$, in which the hypotenuse and leg of one will equal the two legs of the other so that the triangles will be similar but not congruent.

Second Solution. Let a and b be the two equal sides of the required triangles, and c and d the respective third sides. Since the corresponding sides of similar triangles are in proportion, there are six possible arrangements of the equal ratios of the sides, but only one that does not lead to an absurdity; namely $a/d = b/a = c/b$. Hence $b = \sqrt{ac}$. For convenience let $a = 1$; the sides then form a geometric series, $1 : \sqrt{c} : c$. A second triangle with sides in the ratio $\sqrt{c} : c : c\sqrt{c}$ will be similar to the first, will have two sides equal to two sides of the first, but will not be congruent to it.

If $c \geqq (1+\sqrt{c})$, no triangle can be constructed. To find for what values of c a triangle is possible, solve this equation, obtaining $\sqrt{c} = \frac{1}{2}(1+\sqrt{5})$, or $c = \frac{1}{2}(3+\sqrt{5})$.

If $\sqrt{c} < \frac{1}{2}(1+\sqrt{5})$ triangles can be constructed.

If $c = 1$, the triangles are equilateral, and a solution is impossible.

In the case of $c < 1$, the triangle is similar to one in which $c > 1$.

Also solved by *J. Murray Barbour; N. Barotz; F. A. Cadwell, St. Paul, Minn.; T. E. N. Eaton; Michael Goldberg, Philadelphia, Pa.; J. F. Howard; C. L. Hunley, Redlands, Cal.;* and *George Sergent, Guatemala.* By considering a decreasing as well as an increasing geometrical progression, *George Sergent* showed that the ratio of similitude must lie between $\frac{1}{2}(-1+\sqrt{5})$ and $\frac{1}{2}(1+\sqrt{5})$.

853. *Proposed by J. F. Howard, San Antonio, Tex.*

Find the sum of all the products of the first n integers taken three at a time.

Solved by Raymond F. Schnepp, Chaminade College, Clayton, Mo.

If we denote the sum of the products of n integers taking m at a time by S_m^n then $S_3^n = n(n^2-1)(3n+2)/24$. Also $S_3^n = S_3^{n-1} + nS_2^{n-1}$

This relation enables us to calculate rapidly some of the products, and taking successive orders of differences by the Differential Method, we obtain results as follows:

The values of S_3^n are 0, 0, 6, 50, 225, 735, 1960, 4536, 9450, 18150, 32670. The differences are 0, 6, 44, 175, 510, 1225, 2576, 4914, 8700, 14520. The differences in this series are 6, 38, 131, 335, 715, 1351, 2338, 3786, 5820. Continuing in this manner, we find that the differences are eventually zero. If now we represent the first term by a, the first order of differences by a_1, the second by a_2, etc., we have:

$a = 0$, $a_1 = 0$, $a_2 = 6$, $a_3 = 32$, $a_4 = 61$, $a_5 = 50$, $a_6 = 15$, $a_7 = 0$.

Since the nth term must equal S_3^n, we have

$S_3^n = a + B_1a_1 + B_2a_2 + B_3a_3$ where B_n are the usual binomial coefficients. Substituting their values, and the values of a_n we get:

$S_3^n = (n-2)(n-1)n^2(n+1)^2/48$.

Also solved by *J. Murray Barbour; N. Barotz;* and the *Proposer.*

854. *Suggested by Problem 838.*

In a right triangle, given the radius r of the inscribed circle and the distance d between the centers of the inscribed and circumscribed circles, find formulas for the sides a and b and the hypotenuse c in terms of d and r.

Solved by J. F. Howard, San Antonio, Texas.

From problem 838 we found $R = r + \sqrt{d^2+r^2}$

But $c = 2R$. Hence $c = 2r + 2\sqrt{d^2+r^2}$.

Using the theorem "The sum of the two legs of a right triangle is equal to the hypotenuse plus the diameter of the inscribed circle" we can write

$$a+b = c+2r. \qquad (1)$$

Also, $2rs = ab$, or $r(a+b+c) = ab$: that is,

$$ab = r(2c+2r). \qquad (2)$$

Solving equations (1) and (2) for a and b,

$$a = 2r+\sqrt{d^2+r^2}+\sqrt{d^2-r^2}$$

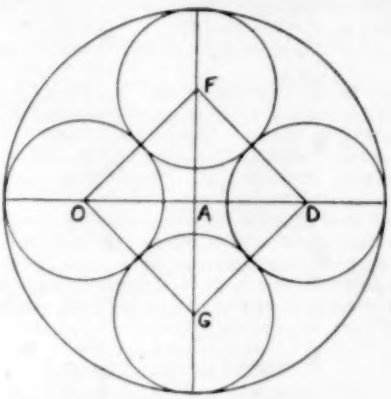
$$b = 2r+\sqrt{d^2+r^2}-\sqrt{d^2-r^2}$$

Also solved by *T. E. N. Eaton; Michael Goldberg; Charles Oergel, Philadelphia, Pa.;* and *George Sergent.*

855. *For High School Pupils. Proposed by Jonas T. May, Mattoon, Ill.*

Within a circle four other equal circles are drawn, each tangent to the large circle and to two of the smaller circles. If the area between the four inner circles is 100 sq. ft., find the radius of each circle.

Solved by the Mathematics Club of the South Philadelphia H. S. for Boys, (Geo. Weisman, Sec.).



Leaving R = radius of large circle, r = radius of small circle.

OFGH is a square.

$$A = (2r)^2 - \tfrac{1}{4}\pi r^2 \times 4 = 4r^2 - \pi r^2 = 100$$

$$r = \frac{10}{\sqrt{4-\pi}}$$

The radius $R = \tfrac{1}{2}OD + r = \tfrac{1}{2}\sqrt{(2r)^2+(2r)^2}+r.$

$$R = \tfrac{1}{2}\cdot 2r\sqrt{2}+r = r(1+\sqrt{2}) = 10(1+\sqrt{2})/\sqrt{4-\pi}.$$

If there is any doubt that OFGD is a square the following is the proof for it.

1. OF, OG are st. lines.	1. When 2 circles are tan. the line of centers will pass through the point of contact.
2. Each side = $2r$. $\therefore$ the diagonals are rt. $\angle$s to each other.	2. The diagonals of a rhombus are at rt. $\angle$s.
3. Also diagonal must pass through the pt. of contact of large circle.	3. same as 1.
4. $\therefore$ AD, AG, AF, AO, = R $-r$ $\therefore$ OFGD is a square.	4. When the diagonals are = and at rt. $\angle$s in a figure, the figure is a square.

This was not the best solution received, especially if we consider grammar as well as mathematics. One good point in the solution is the retention of the symbol π and the radicals until the expressions for r and R have been found rather than the introduction of such numbers are 3.1416 and 1.414. But the final answer should be given as $r = 10.8$ ft. and R = 23.1 ft.

Also solved by

Dickinson H. S., Jersey City, N. J.; Emil Dadivson, John Howley, David S. Milne, Andrew Pelzer, and Charles Roede (who gave the best proof of the geometrical steps).

Redlands H. S., Cal.: Francese Buckmaster, Russell Huckaby, Grace Osterheert, Seymour Tucker.

Siskiyou Union H. S., Yreka, Cal.: Elsie Tebbe, James Beall.

PROBLEMS FOR SOLUTION.

866. *Proposed by A. G. Haynes, Bishop Cotton School, Bangalore, India.*

Given the three altitudes of a triangle, construct the triangle.

867. *Proposed by J. Kelm Thornton, Fillmore Union H. S., Cal.*

A and B gamble on the heads and tails of a coin. A is to flip the coin and cover B's bets. B is to start with $100 and to bet half of what he has each time. He quits after four throws and has won twice and lost twice. How much money might B have when he quits?

868. *Proposed by John Ankebrant, River Rouge, Michigan.*

A farmer has a circular field containing 10 acres. A cow is tethered to a point on the circumference. What is the length of the rope if the cow can graze over one acre of the field?

869. *Proposed by the Mathematics Club of the South Philadelphia High School for Boys.*

In the October issue the statement was made that all geometrical constructions which use only the compass and straight edge can be performed by the compass alone. Hence we submit the following problem:

Given the points A and B determining the line AB, and the points C and D determining the line CD. Find E, the intersection point of the two lines, using only the compass.

870. *For High School Pupils. Proposed by the Editor.*

Chester and Kenneth were discussing just how much is saved by walking diagonally across a rectangular field instead of walking along two sides. Kenneth said "If you inscribe a circle in one of the triangles formed by drawing the diagonal, the diameter of the circle represents the distance saved." Prove he was right.

SCIENCE QUESTIONS.

CONDUCTED BY FRANKLIN T. JONES

The White Motor Company, Cleveland, Ohio.

To Readers of School Science and Mathematics:

You are invited to propose questions for solution or discussion.

You are asked to answer questions.

Examination papers are always desired. Send in your own papers or any others. Some are interested in college entrance examinations, others in school or college examinations. All are desired.

Please address all communications to Franklin T. Jones, 10109 Wilbur Avenue, S. E., Cleveland, Ohio.

QUESTIONS FOR SOLUTION.

456. *Proposed by George B. Eisenhard, Culver Military Academy, Culver, Ind.*

When a boy, our crowd used to go swimming under an old leaky aqueduct where the canal crossed the river. We were always cautioned to get out from under the aqueduct when a canal boat went by.

What additional danger, if any, was occasioned by the passage of the boat?

What misapprehension, if any, caused the warning?

(Try this on a class and find out how many think the question straight.)

457. *The Panama Canal problem of Mr. Worcester R. Warner repeated.*

(In response to numerous requests this problem is reprinted. Many teachers are using it as a test of *consecutive* thinking. What are the *correct* answers?)

The Panama Canal Locks at Gatun are in a series of three, each 1,000 feet long and 110 feet wide. Each of the three locks raises or lowers a ship 28 feet.

Gatun Lake is, therefore, 84 feet above sea level.

It is desired, first, to determine the quantity of water required to take each ship—one at a time—from the Caribbean Sea into Gatun Lake; and, second, the quantity of water required to return each ship—one at a time—from the lake to the Caribbean Sea again.

Answers are required in tons, computed by the following formula: Cubic feet of water x .028 = tons.

Let us suppose a ship has just come down from Gatun Lake to the Caribbean Sea. The ships "A" and "B" are waiting to be taken from the sea to Gatun Lake, and back to the sea again, "B" to follow "A" in each direction.

Question 1: How much water must be taken from the lake to take "A" from the sea into the lake?

Question 2: How much water must be taken from the lake to take "B" from the sea into the lake?

Question 3: How much water must be taken from the lake to take "A" from the lake to the sea?

Question 4: How much water must be taken from the lake to take "B" from the lake to the sea?

The displacement of these ships is 35,000 tons each.

SOLUTIONS AND ANSWERS.

452. *Suggested by a newspaper clipping.*

(1) What can a horse pull?

(2) Can a horse pull more than its own weight?

(3) Can a locomotive pull more than its own weight?

(1) *Answer for the Cleveland Plain Dealer:*

"Tests made recently proved that a pair of horses, each weighing 1,600 pounds, could haul a load 550 pounds greater than themselves.

"On a metal track, one of the animals, it has been shown, can draw one and two-thirds times as much as on a good asphalt surface, five times as much as on cobblestone paving, and twenty times the load it can pull on an ordinary mud road.

"For the usual type of farm horse, a cart carrying a weight of 1,500 pounds is considered to be a fair task. While pulling light vehicles and under saddle, records indicate that horses are equal to great feats of strength and endurance.

"A twenty-year-old beast hitched to a light cart is known to have traveled a hundred miles in less than thirteen and a half hours and was in excellent condition at the end of its journey."

(2) The horse can keep in motion a load greater than it can start. Also, it is a well known fact that a team will start loads greater than its own weight when the loads are on wheels. It is quite a problem, however, to disturb the equilibrium of the load in the direction of motion.

(3) A locomotive can, on a level track, start a horizontal force equal to about one-half its weight. The load started may weigh many times the weight of the locomotive.

The following paragraphs descriptive of a test of a steam locomotive against an electric locomotive are very interesting. It is a fact not taken account of in the writeup that the electric locomotive outweighs the steam locomotive:

"The two locomotives were coupled together, old and new, for a tug-of-war, and repeatedly the new pulled the old over the line, even when the steam engine was given a running start of ten miles an hour.

"The rate of speed acceleration is a boasted point of vantage with the electric. It picks up speed at the rate of two miles an hour each second for the first twenty seconds. At the end of the first minute it runs sixty miles an hour, at the end of the second minute 105 miles an hour.

"I admit the superiority of the electric locomotive in some respects," said a railroad engineer, "but that doesn't mean we are going to scrap all our steam engines right away. It's largely a question of economy.

"The steam locomotive does its best work on a long, steady pull when it gets under way. Any series of tests such as we have had here will demonstrate the apparent superiority of the electric.

"The reason is that the steam locomotive is driven by pistons which, in their travels, come to a dead center where no power is being applied to the driving wheels. In the case of the electric the power is being applied evenly to all the driving wheels all the time."

The following extract from *Science Items* is also interesting:

"When it comes to an example of industry in the brute creation, man should no longer consider the ant, but the gopher, according to Professor Joseph Grinnell, of the University of California, who has been making a careful study of these little animals. As a result, he has estimated that in Yosemite National Park alone they bring to the surface from their burrows enough dirt to fill 160 freight cars of 50 tons each, and that in so doing they expend 5,500 foot-tons of energy."

ARTICLES IN CURRENT PERIODICALS.

American Botanist, for October, Joliet, Ill. $1.50 a year, 40 cents a copy. "Summer Across the Prairies," O. A. Stevens; "Plant Names and their Meanings"—XXI Orchidaceae.

American Journal of Botany, for December. Brooklyn Botanic Garden. $6 a year. 75 cents a copy. "The Relation of Environment to Disease in Plants," L. R. Jones; "Recent Advances in Cytology," Lester W. Sharp; "Studies in the Life History and Physiology of Certain Smuts," George B. Sartoris.

American Mathematical Monthly for November, Lancaster, Penn. $5 a year, 60 cents a copy. "The International Mathematical Congress at Toronto," by W. D. Cairns; "The Mathematical Association," by W. D. Cairns; "Annual Meeting of the Texas Section," by H. J. Ettlinger; "On the Integrability of a Continuous Function," by H. J. Ettlinger; "The History of Modern Calculating Machines, an American Contribution," by L. L. Locke; "The Theorem on the Moment of Momentum," by O. D. Kellogg; "On a Transformation by Paper Folding," by C. A. Rupp; "The Use of Prognostic Tests in Sectioning College Freshmen in Mathematics," by M. A. Nordgaard; Questions and Discussion: Discussions.

Condor for November-December, Pasadena, California. $3 a year, 50 cents a copy. "The Study of Bird Sounds," Aretas A. Saunders; "Some New Records for Northeastern California," Joseph Mailliard; "A Survey of the Song Sparrows of the Santa Barbara Islands" (with two figures), A. J. van Rossem; "Variability in *Bubo virginianus* from Rancho La Brea" (with five graphs), Rachel A. Husband.

Education for November, Boston, Mass. $4 a year, 40 cents a copy. "A Constructive Program for Moral and Civic Habit Formation," Stephen G. Rich; "Some Objectives in Twentieth Century Education," Walter McNutt; "The Aims, Contents and Methods of a General Course in Educational Sociology," Clyde B. Moore.

Journal of Chemical Education, for December. $2 a year. "The Position of the Metals in the Introductory Course," R. A. Baker; "Should Teachers do Research or Commercial Work?" C. C. Hedges; "A Plea for Rationally Co-Ordinated Courses in Analytical Chemistry," Paul H. M. P. Brinton; "Brands from the Burning," Elliot Q. Adams; "A New High School Course in Chemistry," Charles H. Stone.

Journal of Geography for October, 2249 Calumet Ave., Chicago. $2.50 a year, 35 cents a copy. "A Suggested Outline for the Treatment of a Geographic Region," Preston E. James and R. Burnett Hall; "The Teaching of Geography in the Elementary Schools," E. E. Keener; "The New Rumanian State: Regions and Resources," E. M. Sanders; "Names of Countries," F. Homburg.

Monthly Weather Review, for August. Government Printing office, Washington, D. C. "Substitution of fruit temperatures for air temperatures in regulating orchard heating for oranges," F. D. Young (8 figs.);

"Oscillations of the Atmospheric Circulation Over the North Atlantic Ocean in the 25-yar period 1881-1905," A. Defant, Transl. and abstr. (2 figs.); Tornado near Fitchburg, Mass., July 17, 1924," C. F. Brooks, (fig.); "The Great Hailstorm in Southeastern New Hampshire and Northeastern Massachusetts, July 17, 1924," B. M. Varney; "Windstorms in Wisconsin, August 7, 1924," W. P. Stewart; "A Further Note on the Lorain, Ohio, tornado of June 28, 1924," B. M. Varney, (3 figs.).

Nature Magazine for January. 1214 Sixteenth Street, N. W., Washington, D. C. $3 a year, 35 cents a copy. "My Friends, the Deer," T. Brazil; "The Flame-Colored Flamingo," C. B. Ely; "The Wolverine," W. MacMillan; "Wonderland of Ice," C. F. Talman; "The Pitcher Plant," A. A. Hansen; "Points About Porcupines," E. H.. Baynes; "Nannyberry and Cranberry," S. F. Hamblin; "Tom and Bob," W. L. and I. Finley; "Silver Pilgrim," B. H. Lampman; "How Grandmother Kept Well," B. L. Putnam; "Evening Skies," I. M. Lewis; "Nature's Cathedral," R. W. Westwood; "Nature Study Review," A. B. Comstock; "Hints to Teachers on Nature Subjects," "Nature News and Views."

Photo-Era Magazine, for December. Boston, Mass. $2.50 a year, 25 cents a copy. "Practical Kinematography, Chapter I," Herbert C. McKay; "The Camera in Star-Land, Part I," James Stokley, M. A., F. R. A. S.; "Photography on a Cold and Frosty Morning," Dan McCowan; "Photographic Falconry," Karl A. Pember; "How to Copyright a Photograph," Studio-Light; "Photographing Alma Mater," Jessie Wilkinson; "Photography in the Languorous Tropics," P. H. Hebert; "If I Were a Photographer," Frank H. Williams.

Popular Astronomy for December, Northfield, Minn. $4 a year. "A Luminous Extension at the Terminator of Mars," with Plate XXVIII, G. Van Biesbroeck; "Calculations of the Heights of Meteors Observed," by H. L. Alden and C. P. Olivier, Charles P. Olivier; "The 'Seas' of Mars," with Plate XXIX, G. H. Hamilton; "Measurements of the Radiation from the Planet Mars," with Plate XXX, Edison Pettit and Seth B. Nicholson; "The American Section of the International Astronomical Union," Joel Stebbins; "Thirty-Second Meeting of the American Astronomical Society" (Concluded); "The Observation of Lunar Occulatations in January and February 1925," L. J. Comrie.

School Review for December. University of Chicago Press. $2.50 a year, 30 cents a copy. "Educational News and Editorial Comment; "The Junior High Schools of Chicago," R. L. Lyman; "Freshman Week at the University of Chicago," Ernest H. Wilkins; "Marks of Students in High School anc Higher Institutions," B. J. Rivett; "A Study Outline Test," F. Dean McClusky and Edward Willian Dolch; "The Social Program for the Unsocial High-School Girl," Caroline Power; "Can High-School Students Spell?" Edith L. Hilderbrand; "Liability of Teachers and School Officials for Statements Made in Connection with Official Duty," I. N. Edwards.

Scientific Monthly for December. Lancaster, Penn. $5 a year, 50 cents a copy. "The Centenary of the Franklin Institute: The Natural and Artificial Disintegration of the Elements," Professor Sir Ernest Rutherford; "The Carbon Atom in Crystalline Structure," Sir William Henry Bragg; "The Best Use of the Waters of the Great Lakes," John F. Hayford; "Population and Progress," George R. Davies; "Botanizing in Ecuador," A. S. Hitchcock; "Mental Hygiene in the University," Stewart Paton; "Stability," T. Wingate Todd; "Why I Teach Evolution," William Patten; "The Physical Basis of Disease," The Research Worker; "Who Profits from Scientific Work?" F. C. Brown.

Torreya for September-October. Lancaster, Penn. $1 a year, 30 cents a copy. "Unreported Plants from Long Island," N. M. Grier; "A New Heart-leaf and other Interesting Plants fron Autauga County, Alabama," Roland M. Harper; "A Trip to El Yunque, Porto Rico," Elizabeth G. Britton.

MAKING USE OF THE ILLUSTRATIVE MATERIAL IN TEXTS.

By Douglas C. Ridgley,

Clark University, Worcester, Massachusetts.

A careful examination of any of the standard geography textbooks reveals an abundance of three kinds of material in the make-up of each book: pictures, maps and graphs, and printed matter.

Every teacher who uses a geography textbook is conscious that these three kinds of material are in the book, properly related to each other for use in the study of every region. Few teachers have stopped to consider the relative amount of space given to each kind of material, or to consider the relative teaching value of each, or to consider whether assigned lessons and required recitations from the textbook have been properly apportioned among these three specific helps for the instruction of pupils. Careful estimates as to the space devoted to each show that the pictures take up about 25 per cent of the space of the books; maps and graphs, 15 per cent; and printed matter, 60 per cent. Forty per cent of the total space is given to illustrative material! How much use is made of this illustrative material? Below are some brief suggestions of methods that have been tried and found to work.

Let us suppose that a class is to study South America during the next few weeks. The following suggestions may be followed, or they may be modified to suit the needs of the teacher and pupils making the experiment:

I. A Study of Pictures.

The first lesson on South America may be assigned thus: For tomorrow study the pictures of South America in the textbook. Look at each picture carefully, in order, and see what it shows. Examine the scenery, the people, the industries, the buildings, and other things shown in the picture. Read the title and explanation under each picture, *after, not before,* you have looked at the picture carefully. After you have examined all the pictures of South America in this way you may make a list of the pictures for use in study in class. Arrange the list on a sheet of paper in the form of a table. For the heading of the table write: PICTURES OF SOUTH AMERICA.

Rule the page in columns, and use these headings for the columns: (1) Page, (2) Number of figure, (3) Title, (4) Country, (5) Direction from Asuncion (the capital of Paraguay), (6) Distance in miles from Asuncion, (7) Latitude (in whole degrees), (8) Longitude (in whole degrees). Fill columns (1), (2), (3), (4) for each picture before filling the other columns. In the recitation, be ready to look at the pictures in regular order and to tell what each means to you.

The recitation may then be centered in giving the facts as learned from each picture and in locating on the textbook map or wall map of South America each scene as nearly as possible. The teacher may well work out a careful interpretation of two or three pictures of different kinds in order to give the pupils her own interpretation of a few pictures as models for their study and results to be attained. The foregoing assignment may be sufficient for two or more lessons. The work suggested is of sufficient value to carry the study out fully as outlined.

For later lessons, teach pupils how to determine the eight different directions on the map, and how to use the scale of miles for measuring distances. These distances should be expresed in hundreds of miles or in fifties, since exact measurement in miles cannot be made from available maps. Columns (5), (6), (7), (8) should be filled out for two or more pictures under the direction of the teacher in order to insure accurate

results. The recitations should aid the pupils to clear visual images of the scenes represented in the pictures. The pupils may consider that they are at Asuncion, and point from there in the right direction to the scenes represented, and give orally the direction and distance to each.

In this study of pictures, the pupils may be permitted to read about the scenes in the textbook or elsewhere, but the attention should be centered in "reading" the pictures with utmost diligence.

II. A Study of Maps and Graphs.

After the complete list of pictures has been studied as suggested, the next lesson may be assigned as follows: For tomorrow make a list of the maps given in that part of the textbook devoted to South America. For the heading of the table write: MAPS OF SOUTH AMERICA.

Use these headings in the columns of the table: (1) Page, (2) Number of figure, (3) Title. After you have made the list, examine each map, in order, and be ready to tell in class what you find on the map. We can learn to "read a map" as well as we can read a page.

Each map should be given as much time and attention in the recitation as interest and good results warrant. The effort should be made to have pupils state in good English sentences the geographic facts shown clearly and accurately on the map. The teacher may work out a complete interpretation of the physical map or the rainfall map of South America and help the pupils at the outset to "read a map" with certainty. In addition to the maps listed in the pages given to South America, the pupils may turn to world maps elsewhere in the textbook and "read" the map of South America. This map study may be continued as long as results seem to warrant. If well done, it is of real value to pupils.

HOW TO MAKE THE GEOGRAPHY EXAMINATION INTERESTING.

By Ina Cullom Robertson,

State Teachers' College, Valley City, N. D.

In the past few years the thought of the educational world has been directed toward the improvement of the testing side of the teaching process. Two notable results have come out of the study, (1) the standardized test and (2) a certain skill in the mechanics of test building. The latter may be applied in the construction of more interesting examinations. The traditional examination, characterized by the "What," "Discuss" and "Locate" type of question has many advantages and many disadvantages; these facts are too well known to need discussion at this time. This type, however, has been and probably will continue to be the most widely used form of educational measurement. It should not be eliminated. On the other hand, there are some newer forms of examinations which are finding favor with educators. While it is not intended to displace the traditional examination through the use of the newer forms, they afford a means of lending variety to the examination practice, which will be welcome, I believe, to both teachers and pupils. It is the purpose of this article to consider some of these tests and show how they may be used in geography.

"True and False" Examination: The "True and False" examination is made up of an equal number of true and false statements. Perhaps, on first thought, the construction of such a test would not appear to be difficult. The following suggestions may prove helpful. As already mentioned, the examination should consist of about an equal number of true and false statements; variation of the number, however, is desirable. The bright pupil soon discovers that the teacher is likely to use

more true statements than false, or vice versa, and may be led to guess rather than think. The statements should not appear in any regular order. Complex, unfamiliar or ambiguous statements should be avoided. Simple statements of truths or principles are best. They may be taken directly from the textbook, or they may be phrased in the teacher's own words. About twenty statements make a good unit for an examination, however, many more may be used.

Space will permit the presenting of only a few statements illustrative of the type.

Example: "True and False" Examination.

Directions: Read the following statements. Some of them are true and some are false. Write the word "true" before the statements you think are true and "false" before the ones you consider false. Each statement correctly marked gives you one credit. Each statement incorrectly marked penalizes you one credit. Omitted statements do not count against you.

1. The Great Valley of California is shut in by the Cascades on the east and the Coast Range on the west.
2. Most of the dried fruit of the Pacific States comes from northern California.
3. Irrigation is carried on more extensively in the northern part of California than in the southern part.
4. The Pacific States have sufficient coal resources for their own needs.

Completion Test: The examination may be varied, also, by the use of the "Completion Test." In the completion test certain key words in the statements are omitted and are to be supplied by the pupils. A list of the words to be used in the exercise may be given or the examination may be varied by omitting the list of words at the beginning.

Example "Completion Test."

The following statements are taken from a well known elementary text in geography.

1. "Drops of rain falling on the forests and fields may soak into the ground and form ——— and run down the slopes to the nearest ———. Brooks and ——— running together as they descend form ———.
2. "When several rivers unite the main stream and all its branches make a ——— ———."
3. "The higher ground that separates one basin from another is a ———."
4. "A stream makes a trough at the bottom of which it flows. This trough is the ——— of the stream."

Advantages Claimed for the New Types of Examinations: The superiority of the new over the old, the untried over the tried is always a lawful question. There are some distinct advantages claimed for these new types of examinations. In the first place through the use of these examinations it is possible to cover a larger field of the subject matter per unit of time than in the case of the traditional examination. It is, therefore, fairer to the student as well as to the teacher, since it more nearly represents the pupil's total field of inquiry. It requires more thorough and careful review on the part of the student because he knows that he will be held for a larger number of questions. Students frequently review only those phases of the work which they think the teacher is most likely to ask. Many students think that they are given credit for their much speaking or writing; they write all around the question but fail to give the fundamental facts wanted. If one is testing for facts the two types of examination given in this article accomplish this with an economy of time and effort. The scoring, too, is easier and fairer to both pupil and

teacher. It is objective rather than subjective. The personal equation of the teacher is eliminated. The traditional examination is criticized because the disposition of the teacher enters so largely into the scoring. Students can see wherein they have made their mistakes and can measure their attainments with those of their classmates. The papers may be scored as easily by the pupils as by the teachers although the teacher should look over the papers to see if they have been properly marked. The examination arouses interest. It is more enjoyable. Pupils try to discover the right answers to the questions which they have missed. This is not always possible in the case of the traditional examination because the students do not know why they have received the mark they have; they do not know what is wrong. The newer type of testing leads to a healthy rivalry in the class. It accomplishes the purpose of the examination most satisfactorily to both teacher and pupil.

WHY EXPERT ENGINEERING SERVICE IS ESSENTIAL AND ADVISABLE WHEN A NEW SCIENCE BUILDING IS BEING DESIGNED.

By F. H. Wiese,
Manitowoc, Wis.

One of our leading state institutions erected a chemistry building several years ago. It is a beautiful building, devoted entirely to instructions in chemistry. The building is fire-proof. The floors are solid reinforced concrete, 14 in. thick.

When the building was complete, and the laboratory furniture was to be installed, it was discovered that supply pipes for water, gas, air, vacuum and waste outlets were located only in the corridors. What did this involve? All the pipes had to be run on the ceilings of the rooms under the laboratories. About two thousand holes had to be drilled through fourteen inch reinforced concrete floors. Who did this work, and who paid for it? Why the manufacturers of the laboratory furniture (who fortunately were experts) included the estimated cost in their cost of installing the laboratory furniture, and the state funds paid the bill, equalling about 20% of the cost of the entire laboratory furniture equipment.

In another instance the architect provided four inch diameter soil pipe for vents to the hoods. This was discovered by a laboratory equipment engineer before the building was erected, and by him changed to the largest size the walls would accommodate, six inch pipe; result, over twice the area, and not any too large at that.

When contemplating the erection of a science building, you wouldn't expect to get along without an architect. The expert engineering service (now available) should therefore be engaged for the important ask of working out all the details pertaining to the designs, location, and quantity of furniture equipment necessary for the performance of efficient work by the faculty.

Your chemist may be with you only a year, or perhaps twenty years. The equipment when selected by them may or may not bring out the best in their successors.

An equipment engineer who has designed, manufactured and installed laboratory furniture in all types of science buildings during the last twenty years, and has met and solved the intricate problems which have developed during that time is as necessary to the success of your new enterprise as the architect.

STAR'S LIFE LASTS 30,000,000,000,000 YEARS.

Thirty trillions of years. Such is the lifetime of a star from its brilliant and gigantic babyhood to faint old age.

This latest computation of the time necessary for the complete evolution and life of a typical star in the heavens has just been reported to the National Academy of Sciences in a communication from Edward Condon, assistant to Prof. A. O. Leuschner of the University of California.

The earth is only a few billions of years old, geologists tell us after a study of radioactive rocks. The human race evolved in the course of a few hundreds of thousands of years. The greatest span of one person's life is little more than a hundred years. Yet such intervals of time are mere flashes in the life of a star.

Einstein, conjurer of time, space, and matter, gave the clue to the secret of stellar age. His idea that mass and energy can be converted one into the other led to the explanation of how a star can exist for great periods of time; throwing off great amounts of energy, and yet continue to shine apparently unchanged in brilliance.

Stars live on their fat, as it were. They gradually convert their mass into energy which they radiate away in the form of light. Young stars are giants, more brilliant and massive than fainter dwarf stars which have had their fling at life. Astronomers believe that the different kinds of stars in the heavens represent different periods or ages through which all stars pass.

Using this assumption, Mr. Condon arrived at 30,000,000,000,000 years as a rough estimate of a star's life.

This gigantic figure will comfort those which have been worried about the constancy and reliability of the earth's power plant, the sun. For the sun is a star; not a large one and it is growing smaller constantly. Four million tons of energy are given off from the sun in the form of light every second.

Yet the new figures on the age of stars indicate that the sun has been shining for billions of years in the past and will continue to shine for billions of years in the future without any great change in brilliance. —*Science Service.*

WHAT'S BALL LIGHTNING? SCIENTIST WONDERS.

What is "ball lightning?"

The expression is ancient. Doubtless some of the millions who have used it have seen lightning that appeared to fit such a description.

But its actual occurrence is very rare indeed. "The strangest of meteors," is how Dr. W. J. Humphreys of the U. S. Weather Bureau describes it.

Very little is known about it. Dr. Humphreys requests that whoever observes this rare phenomenon send him a complete description with the following details: date, witnesses, geographic location, time during the storm, duration, color, size, shape, sharp or blurry outline, whether with or independent of wind, direction of motion (vertical, inclined or horizontal), kind of motion (smooth or jumpy), effects produced, indoors or outdoors, and if the former, how it got in.

All the previous writing on the subject contains very little real information, Dr. Humphreys says.—*Science Service.*

CANADIAN ANIMALS NEAR EXTINCTION.

Depletion of the larger game animals, even in the deepest Canadian wilds, is a disaster that hangs over the heads of the present generation, in the opinion of Dr. Rudolph Martin, chief of the division of biology of the Victoria Memorial Museum at Ottawa, expressed before the British Association for the Advancement of Science.

Not only have hunters and trappers nearly exterminated many fur-bearing species for the supply of the markets of fashion, but the breaking up of the prairies under the plow has deprived many hoofed and horned species, like the prong-horn antelope, the bison, and members of the deer family, of their pastures and is killing off the species by preventing natural increase. A last refuge of many animals, and one which Dr. Anderson believes should be theirs in perpetuity, is the Arctic.

"A large area of arctic and sub-arctic lands beyond the range of possible cultivation are still occupied by large numbers of wild caribou and a few remnants of musk-oxen," he said. "The Arctic can never be agricultural, but there is a probability of developing a domestic reindeer industry in certain districts and attractive possibilities in attempted domestication of the musk-ox. The economic advisability of replacing a valuable, healthy and thoroughly adjusted wild stock by more expensively reared domestic stock in remote districts is questioned.

"The proportion of the Canadian Arctic area which is actually suited for pasturage is largely problematical and needs investigation rather than speculation. Tundra is not prairie, but consists mostly of mossy swamps or comparatively barren upland. Many extensive areas are rocky or sterile and severe climatic conditions reduce materially the amount of vegetative growth on the limited fertile areas, so that a much greater acreage is required for the support of each animal than in more friendly regions. Population must necessarily be sparse outside of mining areas and enormous distances from markets will prevent profitable commercial exploitation under present methods of transportation."

Dr. Anderson's remarks concerning the Canadian arctic regions apply with equal force to American possessions in interior Alaska, and to vast tracts in northern Siberia, which can never be cultivated, but must remain as permanent grazing lands.—*Science Service.*

CHINESE PROGRESSING IN MODERN BOTANY, SAYS CHICAGO PROFESSOR.

Prof. John M. Coulter, head of the department of botany of the University of Chicago, lectured during the session of the British Association for the Advancement of Science on the progress of botanical study and research in China, as he saw it during his recent five-months' visit. The most important botanical work, said Dr. Coulter, is being conducted at the National South-Eastern University of Nanking and at Nanking University. It is notable in being concerned chiefly with practical problems in developing the natural resources of the country. The untouched possibilities of China are most impressive. The College of Agriculture of South-Eastern University at present has one large experiment station and nine substations, all well equipped.

The principal botanical enterprises under way in China are, first, a complete collection of the native plants of Central China, not only for purposes of classification but also as sources of valuable raw materials and drugs; second, reforestation, for most of China is completely denuded of trees; third, improvement of vegetables, notably the soy bean; fourth, improvement of cotton, fifth, studies on bamboo; sixth, problems of plant disease.—*Science Service.*

DISCOVER UNIVERSE'S LARGEST STARS 10,000 TIMES BRIGHTER THAN SUN.

The most conspicuous stars in the Magellanic Clouds are greater in size and in brightness than any of the giant stars heretofore known to astronomers, according to investigations just announced by Dr. Harlow Shapley, director of the Harvard College Observatory. Many of these stars are believed to excel the far-famed red giants Betelgeux and Antares, and in diameter probably approach the diameter of the orbit of Jupiter, some 966,600,000 miles.

Extensive photometric work has led finally to the determination of the distance of the Small Magellanic Cloud. Similar investigations are under way for the Large Cloud. These stellar systems, which are visible only in southern latitudes, derived their name from descriptions given four hundred years ago by the navigator Magellan. They look like large patches of the Milky Way, but are quite detached from the Galaxy.

Through a prolonged study of the variable stars discovered in the Magellanic Cloud by Miss Leavitt at the Harvard Observatory twenty years ago, a method has been developed for the determination of the distances of star clouds and clusters. Only this year, however, has it been possible to give a decisive value for the magnitudes of the stars in the Small Magellanic Cloud, and consequently to measure the distance and dimensions of the system. It is now found that the diameter of this Cloud is sixty-five hundred light years. The distance from the earth is thirty-two kiloparsecs, which is equivalent to a little over a hundred thousand light years. A star of the luminosity of our sun would at this distance be of the twenty-third magnitude.

Stars as faint as our sun in this cloud, however, are far beyond the range of modern telescopes. The studies of brightness on the Harvard photographs, which were made at the Arequipa station in Peru, go down only to the stars of the eighteenth magnitude.

More than half a million stars that are at least a hundred times as luminous as our sun are contained in the Small Magellanic Cloud. A few hundred of them have each more than ten thousand times the solar brightness. The very brightness of the super-giants are shown by photographs of their spectra to be of the redder classes of color. Hence the intensity of light emission must be low, and, to account for such high total brightness, the dimensions must be exceedingly great. It is calculated that the diameters of the largest super-giants are nearly a thousand million miles. This is at least three or four times the diameter of Betelgeux, and is probably very near the maximum diameter possible for a luminous star.

The Small Magellanic Cloud is known to be receding from the Galaxy with the enormous velocity of a hundred miles a second. Dr. Shapley points out that almost certainly both the clouds of Magellan were in the Milky Way at a time more recent than the paleozoic era, and were then indistinguishable from the other star clouds of the Milky Way.—*Science Service.*

DO HEAT, MOTION AND ENERGY DISAPPEAR AT ABSOLUTE ZERO?

Is 459 degrees below zero Fahrenheit the bottom of the thermometer scale?

This question has been raised by recent calculations of Drs. Bennewitz and Simon, physicists in the University of Berlin. The peculiar habits of hydrogen at very low temperatures lead to the belief that the substance may have a little energy left even when reduced to the so-called "absolute zero," which is 459 degrees below zero Fahrenheit. The re-

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markably low melting-point of hydrogen, 434 degrees below zero Fahrenheit points to this conclusion. If such energy exists, there may be heat, and so the logical possibility of a still lower temperature.

Refractory gases like hydrogen and helium contract on cooling at a rate that would make them reach a volume of zero at 459 degrees below zero Fahrenheit, provided they did not liquefy on the way down. Thus the absolute zero has been thought by some to be the point where all heat energy and motion disappear. This view receives some support in the remarkable experiments of the noted low-temperature investigator, Kamarlingh Onnes of Leyden, Holland. After prolonged efforts Onnes has come within about one degree of the absolute zero, but seems to be close to a positive limit. However, no cautious scientist is willing to say that there can be no such thing as a temperature below absolute zero. —*Science Service.*

REMARKABLE NEW BERRY DISCOVERED IN FLORIDA.

The elevation of the humble gooseberry from its present position as a minor fruit good only for pies and preserves to the dignity of a table fruit on a par with cherries, plums and grapes, is one of the possible results from the discovery of a new species in the woods of northern Florida, a region where gooseberries have never before been known.

Gooseberries are not properly appreciated in this country, is the opinion of Dr. Frederick V. Coville, botanist in charge of the Office of Economic and Systematic Botany, Bureau of Plant Industry, whose description gives the new species to science. Abroad, the fine European varieties are eaten ripe, as table fruit. But these choice varieties are subject to disease in this country, and all the hardy native species known until the present time have berries too small and poorly flavored to be of much value. Moreover, gooseberries as well as currants harbor one phase of the deadly blister rust disease that is threatening our forests of white pine, so that government forest officials are urging that gooseberry culture be strongly curtailed..

Into this rather unpromising setting the new Florida species comes almost like a horticultural fairy godmother. It is probably the biggest wild gooseberry ever discovered, the fruits reaching seven-eights of an inch in diameter. A hybrid with the large-fruited European varities need not lose size. It is native in northern Florida, far south of the present centers of gooseberry culture, and what is even more important, far south of the white pine region. Therefore it can be cultivated without regard to the white pine blister rust, and there will be the added advantage of having berries ready for market much earlier than at present. And it seems to be quite immune to the mildew disease to which the European varieties are susceptible.

In its present wild state the fruit has one notable drawback. Each berry is covered with so many long, sharp spines, that it suggests a little porcupine. It is hoped that these can be eliminated in the breeding experiments now under way at the Department of Agriculture.

The honor of the discovery of this promising berry is divided between Prof. Herman Kurz of the Florida State College for Women and Dr. Roland M. Harper of the Florida State Geological Survey. They came upon it in the woods along the shore of a little lake near Tallahassee in the course of a Sunday botanizing trip. They notified Doctor Coville, as the recognized expert in this part of the botanical field, and after several trips to the region to obtain specimens, seeds and bushes for transplanting, he announced the find to the scientific public.—*Science Service.*

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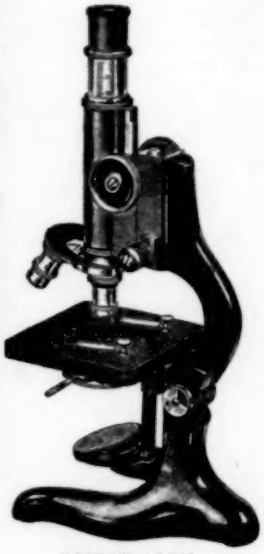

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FOREST SURVEY SHOWS SERIOUS PAPER PROBLEM.

Americans no longer can look upon the cheap daily newspaper as something inevitable every morning and evening. An extensive research just completed by the United States Forest Service has brought out alarming statistics on the depletion of wood pulp reserves in the United States.

American paper requirements now exceed eight million tons a year, or 56 per cent. of the world consumption. Wood constituted 90 per cent. of the raw material from which this is manufactured. In 1922, 9,148,000 cords were required.

American forests today supply only 49 per cent. of this wood. As recently as 1899 they supplied 83 per cent. Of the amount used in newsprint production, the domestic supply furnishes only one-third. Canada supplies the pulp wood for 37 per cent of our entire paper requirements.

The forests of the older lumber sections of the United States are being cut much more rapidly than they are replaced by new growth. In most regions the original timber supplies have been greatly reduced.

The problem as stated by the Forest Service, is to secure annually from our own forests more than a million cords additional to offset pulpwood imports, approximately five million cords to offset pulp and finished paper imports, and to insure a sufficient growth to supply the needs of the future. It is estimated that a total of about 15 million cords will be required for this purpose by 1950.

Three possible solutions are suggested by the government: First, new or modified pulping processes may increase the number of species available for paper. Pine or larch, it is suggested, may be made to take the place of spruce, fir and hemlock in sulphate-pulp production.

Second, paper manufacturing must be conducted more economically. Reduced pulping waste in the chemical process, re-use of waste paper to a greater extent, and more coordination between the lumber and sawmill industries, must be aimed at. Only about 45 per cent of the original wood weight now appears as pulp. Re-use of waste paper has grown to 29 per cent. of our total production, but it can be increased to furnish a much greater contribution than its present 1,850,000 tons a year.

Finally, the Forest Service states, "The main reliance in ultimately meeting our pulp wood requirements must be placed on the growing of timber. The possible margin of growth on our present area of forest land, under intensive forest management, over the present drain, would ultimately amount to about 12 million cords of the pulp species. To this could be added about 11 million cords now lost annually by fire and disease.

"To this could be added about 2,000,000 cords annually from Alaska. Out of this total could be met the 10½ million cord difference between the present cut from our forests and the ultimate requirement of 15 million cords, and leave a substantial margin."—*Science Service.*

ADVANTAGES OF RURAL JUNIOR HIGH SCHOOLS.

Junior high schools in connection with union free high schools as a means of bettering conditions in the rural school is suggested in a report issued by the State department of public instruction of Wisconsin. Many advantages are pointed out. Limiting the number of subjects and classes in the small rural schools to the first six grades would permit grading and greatly simplify the preparation for rural teaching.

Much more important is the fact that removal of pupils of junior high school age from country schools would make possible a readjustment of the school year. Country schools may be closed during the cold weather and open during a great part of the summer when the younger children are not needed at home. Better attendance, better teaching, and less retardation are seen as points in its favor.

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COTTON ACQUIRES A NEW CAMOUFLAGE.

By Dr. Edwin E. Slosson.

Cotton is a social climber. Handicapped by its lack of the sheen of silk or the luster of linen or the warmth of wool, it is now gaining upon its rivals by aid of the chemist.

Silk, the aristocrat of textiles, gets the gloss that is the envy of the rival fibers from being forced out in a viscous from the tiny orifices of the spinnerets of the silkworm, solidifying as a single slick smooth cylinder a thousand yards long.

Cotton, on the contrary, if you compare it under a microscope, looks like a short twisted tape, and wool like a rough and scaly rope. Cotton, to quote an old joke, shrinks from soaping—like a small boy. Dipping cotton into strong alkali causes the fibers to shorten and thicken and soften. Seventy-five years ago it occured to an English chemist, John Mercer, to try what would happen if the cotton were not allowed to shrink. So he kept the thread or cloth on stretchers while it was dipped into a solution of caustic soda and left to dry under tension. The lye took the kinks out of the cotton and softened its surface and this gave it something of the luster of silk. So Mercer immortalized himself, like J. L. MacAdam, the road-maker, by converting his name from a proper noun to a verb, and we have had "mercerized" cotton ever since.

Now a new method of treating cotton has been invented. This is the opposite of the mercerization process for it is produced by acid instead of alkali. Charles Schwartz of the Philana Company at Basle, Switzerland, has found that cotton may be made to resemble its other rival, wool, by immersing it in concentrated nitric acid. The fibers become more curly and their surface rougher, and the fabric assumes the texture of a new material to sight and touch. The tensile strength is said to be increased by fifty per cent. and the resistance of the surface against scraping to be improved by two hundred per cent. In wear and warmth and appearance the philanized cloth resembles woolen.

We might suppose that the action of nitric acid on cotton would produce nitric-cellulose, otherwise known as gun-cotton. It would not be pleasant to go about clothed in a high explosive. But in making nitrocellulose sulfuric acid is needed to facilitate the reaction of the nitric. In the present process the nitric acid merely attacks the surface and is all washed out afterward, or eliminated by alkali. The cotton acquires a yellowish tinge but this may be removed by bleaching. The philanized fabric may be later mercerized and this makes it look like linen. It is said to dye more readily and brilliantly than untreated cotton. One of the leading German dye works is using the new process.

In England nitric acid is being applied to the improvement of ramie, an Indian fiber. When ramie under tension is treated with nitric acid, it acquires a silken luster. When not stretched, it resembles wool. Three minutes dipping in the cold concentrated nitric acid is sufficient for the effect. The fiber gains slightly in weight and considerably in strength and takes dyes better.

The chemist has made a new market for cotton waste by dissolving it completely in nitric acid, alkaline sulfide, or acetic acid, and spinning out the viscous fluid into threads of any length, size and shape that he pleases, producing thereby a synthetic fiber that closely simulates silk in appearance if not in strength. Fifty per cent. of what seems to be silk nowadays comes from the chemical laboratory instead of from the cocoon. By taking on the chemist as an ally King Cotton is enlarging his realm.—*Science Service.*

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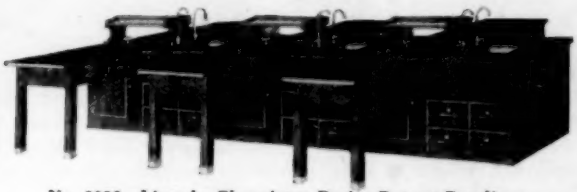

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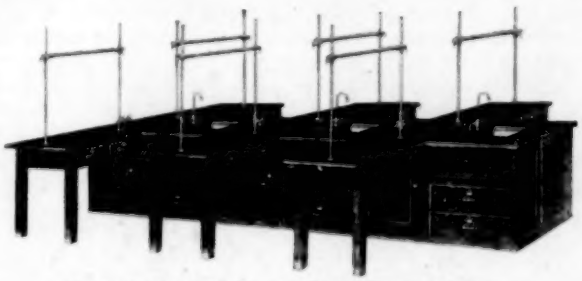

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THE SUN'S PLACE IN THE UNIVERSE.

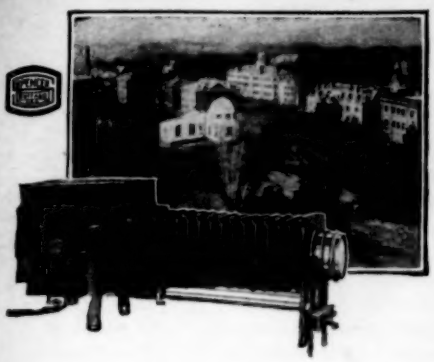
By Isabel M. Lewis,
Of U. S. Naval Observatory.

Statistics of the stars, which are becoming increasingly valuable each year as the astronomer finds new and illuminating data continually coming to hand, do not give our sun such a flattering position in the universe as we might wish. A small, yellow, dwarf star is its rating in a universe of some hundreds of millions of stars, similar in size and appearance to many million other stars; its position fifty light years above the central plane of the Milky Way and fifty thousand or more light years from its center, in the midst of a local star-cloud, not over three thousand light years in diameter, which is more or less permeated with and enveloped by vast expanses of dark nebulous matter.

It was but a few centuries ago that man looked upon the sun as an attendant of the earth which was then held to be the center of creation. Then it came about, surprisingly, that the sun was after all the ruler of its own system and the earth an attendant of the sun, a rather puny one at that compared to some members of the solar system. It was a thought to which the human race has not yet completely adjusted itself. Still man clung to the belief that the sun was the center of the universe, for the distances and distribution of the stars were unknown. It was the general idea that the stars were all equally far away, arranged in a sort of spherical shell with the sun at the center. Another unpleasant shock was still to come to the geocentracally inclined members of the human race. New and surprising facts about this sun of ours were gleaned from the life studies of many astronomers as the years passed on. The stars were not all equally distant but were flowing to and fro in streams in or parallel to the Milky Way and the sun was moving onward through space at the rate of a million miles a day, one of the units in a star stream. The distances of the stars turned out to be tremendous, inconceivable. The nearest star was something like twenty-six trillion miles away. Its light took four and a third years to reach us though it traveled 186,000 miles every second. Other stars were found, ten, a hundred, a thousand times more distant. Each star had the comfortable elbow room of several trillion miles on the average, its distance from its nearest stellar neighbor. Old, conservative ideas of the universe were completely upset. As a last straw for the old geocentric theorists came the discovery of the present decade that we are something like fifty thousand light years from the center of the universe, or possibly *one* universe, which consists of the vast lens-shaped aggregation of hundreds of millions of stars known as the Milky Way or Galaxy with its center far away in the direction of the star clouds of Sagittarius.

Though Dr. Harlow Shapley's estimate of three hundred and fifty thousand light years for the diameter of the Milky Way has not passed unchallenged by some astronomers who consider it of the order of ten times too large, the general weight of the evidence at present seems to be in favor of this greater estimate of the size of the Milky Way. It is to the Milky Way system of stars that our own sun belongs and through it we are moving with the sun, about which we circle, at the rate of a million miles every day, six million million or six trillion miles in 15,750 years.

At that rate it would take us pretty close to eight hundred million years to reach that coveted position at the center of the universe. But the sun is old, at least several billion years old, it is suspected, and, who knows maybe we were there once in past ages and will get there again some day!



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INSECTS COST AMERICA TWO BILLION A YEAR.

Losses equal to $20.00 a year for every man, woman and child in the United States are caused by insects, and the insects are still on the increase, Prof. J. J. Davis of Purdue University says in a report to the Indiana Academy of Science.

The greater abundance of insects now than formerly is explained as due to civilization having brought about unnatural conditions which have interfered with the natural balance among plants and animals. Among the principal causes which have produced this interference, Prof. Davis mentions the extensive and continuous cultivation of the same or related crops, which is favorable to insect reproduction by offering unlimited food supplies continuously year after year. Corn root aphis and corn root worm, for instance, become more severe when corn follows corn.

Another factor, he points out, has been the eradication or reduced supply of the native plants upon which the insects formerly lived. Curculio existed only on wild fruits before cultivated varieties were introduced, and the rose root worm which now attacks roses in greenhouses at one time only attacked wild species.

Transportation has also played an important part in the spread of insects and more than half of our destructive pests are of foreign origin. They are not necessarily pests of prime importance in their native home, but brought here and finding favorable breeding places with the absence of their natural enemies, they are capable of increasing with scarcely any restriction. Notable examples include the Hessian fly, San Jose scale, Oriental peach moth, currant worm, cabbage maggot, cabbage worm, wheat midge, European corn borer, gypsy and browntail moths, Japanese beetle, cotton boll weevil, pink bollworm and elm leaf beetle.

Even within our own country transportation has had a marked influence on the spread of insect pests. The San Jose scale, first introduced into America at San Jose, California, from China, was carried in shipments of nursery stock across the entire continent to New Jersey, from which place it was soon distributed to many other sections of the country.

Increase in population, reduction of forests, and hunting, Prof. Davis declared, had also helped the insects by reducing the number of birds and animals which feed upon them.—*[Science Service.*

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Mathematical Essentials, Book two. Pages xiii+237. Lynn and Carnahan, Chicago.

The Law of Diminishing Returns, by W. J. Spillman, Georgetown University. Pages xii+178. 13.5x19. Cloth. 1924. $1.50. World Book Co., 2126 Prairie Ave., Chicago.

Essentials of Applied Calculus, by Robert E. Thomas. The Military College of South Carolina. Pages xviii+408. 14x20 cm. Cloth. 1924. $2.50. D. Van Nostrand & Co., New York City.

Junior High School Mathematics, by William L. Vosburgh, Teachers College, Boston; Frederick W. Entleman, Mechanics Arts High School, Boston, and Jasper O. Hassler, University of Oklahoma, Norman. Pages ix+294, 13x19 cm. Cloth. 1924. The MacMillan Co., New York City.

Elementary Algebra, by John P. Hopkins, Galveston Public Schools, and P. H. Underwood, Ball High School, Galveston. Pages ix+338+xxiii. 13x19 cm. Cloth. 1924. The MacMillan Co., New York City.

Junior Mathematics, Book One, by Ernst R. Breslich, University High School, University of Chicago.

Botany of Crop Plants, by Wilfred W. Robbins, University of California. Pages xxi+674. 14x20 cm. Cloth. 1924. P. Blakistons Sons & Co., Philadelphia.

Chemistry in Industry by H. E. Howe, Editor Industrial and Engineering Chemistry. Pages xii+372. 14x21 cm. Cloth. 1924. $1.00. American Chemical Society, 85 Beaver Street, New York City.

Paths to Success by Harold G. Black, Hollywood High School, Los Angeles. Pages vii+304, 13x19 cm. Cloth, 1924. D. C. Heath & Co., Chicago.

The Electron, by Robert A. Millikan, Director Norman Bridge Laboratory of Physics, California Institute of Technology, Los Angeles. Pages xiv+293. 13x19 cm. Cloth. 1924. The University of Chicago Press.

Outlines of Economic Zoology, by Albert M. Reese, West Virginia University. Pages xix+318. 14x20 cm. Cloth. 1924. P. Blakiston's Son & Co., Philadelphia.

Applied Physics, A Laboratory Manual, by W. D. Henderson, University of Michigan. 82 pages. 20.5x28 cm. Cloth. 60 experiments. 1924. Lyon and Carnahan, Chicago.

Mathematics for Technical Students, by E. R. Verity, Technical College, Sunderlund, Eng. Pages xi+467. 14.5x22.5 cm. Cloth, 1924. $4.00. Longman, Green and Co., New York City.

Mental Measurement in Educational Vocational Guidance, by John M. Brewer, Harvard University. Pages vii+46. 15x21 cm. Paper. 1924. Harvard University Press, Cambridge, Mass.

Experimental Science I Physics, by S. E. Brown, Headmaster Liverpool, Eng., Collegiate School. Bound. 91 pages. 12.5x18.5 cm. Cloth. 1924. 3s 6d. Cambridge University Press.

Methods in Plant Histology, by Charles J. Chamberlain, University of Chicago. Pages xi+349. 15.5x22 cm. Cloth. 1924. $3.37. Postpaid. The University of Chicago Press.

Health for Every Day, by Maurice A. Bigelow and Jean Broadhurst, Teachers College, Columbia University. Pages vii+238+xii. 13x19 cm. Cloth. 1924. Silver, Burdett & Co., New York.

Health in Home and Neighborhood, by Maurice A. Bigelow and Jean Broadhurst, Teachers College, Columbia University. Pages vii+328. 13x19 cm. Cloth. 1924. Silver, Burdett and Co., New York.

Teaching Junior High School Mathematics: Harry C. Barber, Public Schools, Newton, Mass.; Pages—XI plus 136; 12x18 Cm.; Cloth, 1924; Houghton, Mifflin Co.,

Regeneration; Jacques Loeb, Rockefeller Institute; Pages—IX plus 143; 15½x23½ Cm.; Cloth, 1924; McGraw-Hill Book Co., New York.

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BOOK REVIEWS.

Visual Education, by Frank N. Freeman. Pages VIII plus 391. 15½x23½ cm. Cloth, 1924. University of Chicago Press, Chicago, Ill.

In this day and age when education by impressions received by the eye—which is, perhaps, the organ from which we receive most of our information—is so prevelant, this volume, edited by Dr. Frank N. Freeman of the University of Chicago, is most timely. It is a compilation of reports of many men who have made a close study of this form of education. It is filled with information from beginning to end as to how this form of education should be presented and the results that one may expect to derive therefrom.

There are many test questions presented. Mechanically the book is well made. It is in ten-point type, many of the questions and tables being set in eight-point. It is printed on uncalendered paper of good grade, and is a book that everyone interested should purchase and study.

C. H. S.

Regeneration, from a Physico-Chemical viewpoint, by Jacques Loeb, member of the Rockefeller Institute for Medical Research. Cloth, 15x23 cm. Pages ix+143, illustrated with 115 figures. McGraw-Hill Book Company, Inc. 1924.

This book is based on a number of papers published in the *Journal of General Physiology*, but now collected and prepared in monograph form for publication. It consists in the presentation of the results of the authors many experiments on regeneration. Even the lay reader knows of Dr. Loeb and his work in a general way. The book will now give all who are interested a chance to study his experiments and the conclusions drawn by the experimenter.

W. W.

Animal Husbandry for Schools, by Merritt W. Harper, Professor of Animal Husbandry, Cornell University. Cloth. 13x20 cm. Pages ix+615, illustrated with 240 figures. Revised edition. The Macmillan Company, 1924.

This is a new and revised edition of a standard book on animal husbandry for high schools teaching agriculture and for short courses in agricultural colleges. There is little need of comment for the book is so well known to teachers and students alike. An appendix to the book gives numerous practical exercises for the students. Score cards are given for each of the types of animals.

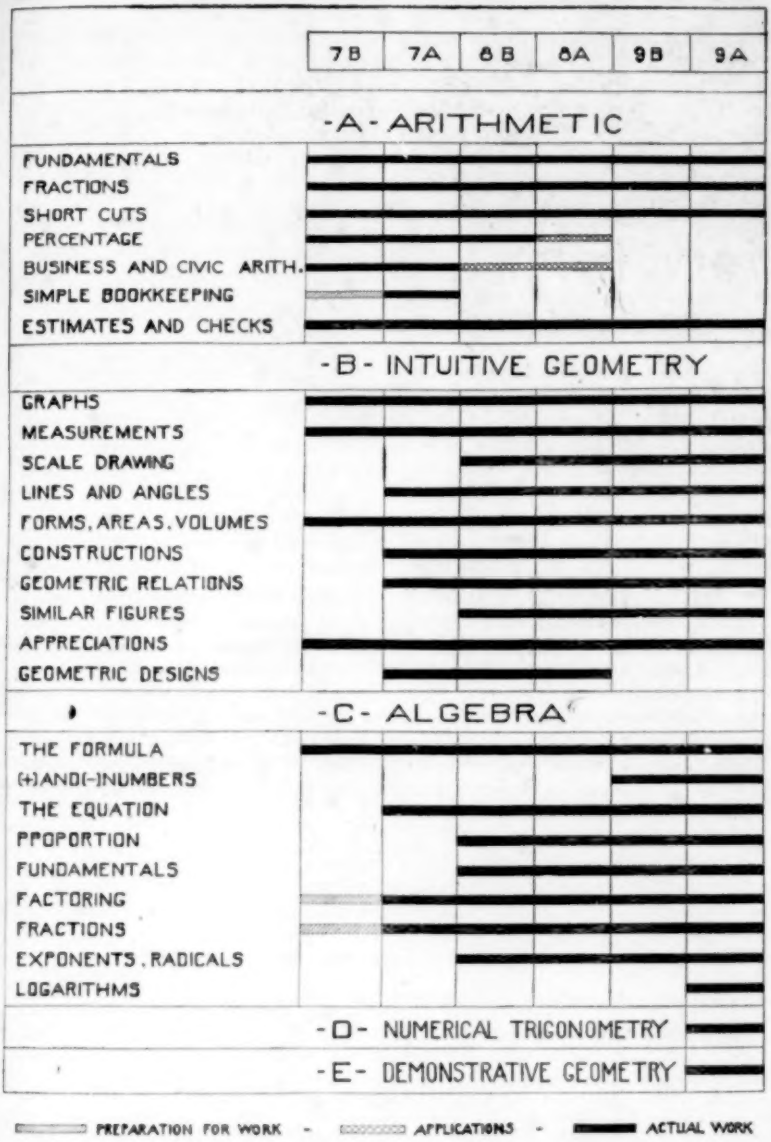
W. W.

Living Things, an Elementary Biology, by Arthur G. Clement, Supervisor of Biologic Science in Secondary Schools, University of the State of New York. Cloth. 13x20 cm. Pages viii+488, illustrated with numerous figures and several colored plates. The Iroquois Publishing Company, Inc., Syracuse, N. Y. 1924.

Of the making of new biology text books there seems to be no end. The book before us disclaims the use of the conventional method of separate parts relating to animals, man and plants, yet it comes near that method. There are five parts, "Principles that unify the subject;" "Application of biologic principles to animals;" "To man;" "To plants;" and "To human interests." The book is written in the usual style without attempting to cut it up into lessons or to give laboratory directions. There are summaries and questions at the ends of chapters. The general plan of the work is very good. The human interest chapters are particularly good.

Exercise and Review Book in Biology, by J. G. Blaisdell, Head of Department of Biology, Yonkers High School. Revised edition, size 20x36 cm. Pages viii+152, illustrated with 21 figures, flexible covers, book perforated and not bound. New World Science Series. World Book Company, 1924.

JUNIOR HIGH SCHOOL MATHEMATICS



The above diagram shows in graphic form the correlation of arithmetic, geometry and algebra in "Modern Junior Mathematics" by Marie Gugle, Assistant Superintendent of Schools, Columbus, Ohio.

The series consists of three books, as follows: Book I for grades 7A and 7B; Book II for grades 8A and 8B, and Book III for 9th grade classes.

Books I and III were recently revised with a view to providing a smoother passage between the work of the first six grades and senior high school mathematics.

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This book is intended for a combined laboratory guide, notebook and review book. It is arranged in four parts. Part I covers introductory lessons on air, water, cells and tissues. Part II relates to animals, Part III to human biology, and Part IV is devoted to plants. There is a section for reviews. The book is very carefully worked out with its questions, requirements for drawings and numerous tables. If large classes must be handled, young and inexperienced teachers may find much help in an efficient way with the use of such a book, providing it is used *intelligently.* W. W.

Biology and Human Welfare by James Edward Peabody, A. M., Morris High School, New York City, and Arthur Ellsworth Hunt, Ph.B., Manual Training High School, Brooklyn. Cloth, xii+584 pages. 13x40 cm. illustrated with 357 figures and plates. The Macmillan Company. 1924.

Biology teachers who have been in the work for ten or more years have seen great progress made in the teaching of biology. A decade ago and even now in many schools, a half year of botany followed by a half year in zoology was called a course in biology. The authors of this book were also the authors of "Elementary Biology" which was a pioneer in emphasizing function but they divided their book into three parts relating to plants, anmals and man, respectively. Their new book is a real biology built around function in fact and entirely eliminating the type method of study. We believe this is the right method at last, and one that will maintain the interest of the student and give maximum results.

The authors are experienced teachers of many years' work in text book preparation. They have put their best into this book. It is as we might expect a good book up-to-date in matter and method. The illustrations are particularly fine. The only thing we fear is that the book is too well worked out—giving the subject matter as it does in measured lessons and projects for both laboratory and home work—so well and thoroughly planned that the teacher may be tempted to let the book do the work he ought to do himself. The text book ought to be a reference book only in the ideal biology class—not a lesson book. We have noticed that eastern teachers are prone to cut up their text books into specific lessons. This is, we suppose, the effort of the teachers to meet certain conditions, such as large classes and short periods and machine-like regularity. Such conditions are to be deplored wherever they exist whether in the East or West.

However, we have nothing but praise for the book. It is good.

W. W.

Fungi and Human Affairs, with Special Reference to Plant Diseases, by W. A. McCubbin, Pennsylvania Bureau of Plant Industry, Harrisburg, Pa. Cloth. 13x19 cm. Pages viii+111, illustrated with diagrams and original drawings and from photographs by the author. World Book Company. 1924. $1.00.

The author of this little book is a plant specialist in the employ of the state. In this work he has felt the need of a simple exposition of the fungi as plants and their relationship to human affairs intelligible to the every day business man or farmer. The author has succeeded in presenting this subject, which really has no end, in an interesting and yet scientific manner and within the ability of its readers both in content and time. The make-up of the book is particularly good and a credit to the publishers as well as to the author who gave the publishers an opportunity with excellent material to publish a fine specimen of the printers art. W. W.

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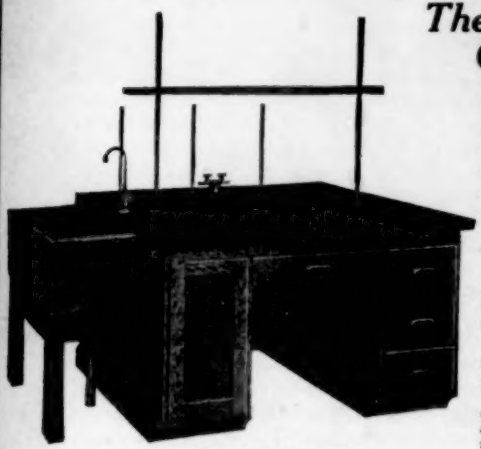

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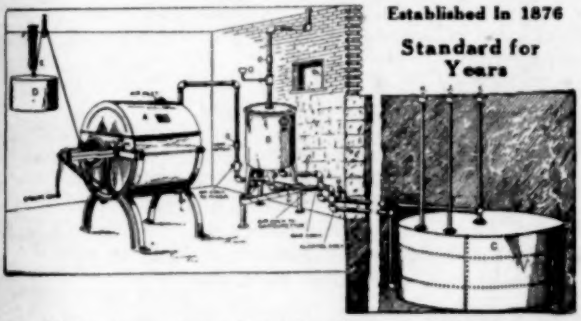

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Elements of Solid Geometry, by David Eugene Smith. Pages VIII plus 238. 13½x17 cm. 1924. Ginn and Co. $1.24.

This book follows "the lists of theorems recommended by the National Committee on Mathematical Requirements and the College Entrance Board as closely as the best principles of sequence and selection seem to warrant." Numerous exercises are interspersed throughout the text. The fundamental theorems are grouped in each book while other propositions are indicated as subsidiary or placed in the supplement. The supplement contains sections on Polyhedrons, Spherical Triangles, Practical Mensuration, History of Geometry, and Important Formulas. The typography and illustrations are excellent. J. M. K.

Elementary Algebra, by John C. Stone, A. M., and Howard F. Hart, A. M. Pages XI plus 316. 14x19 cm. 1924. Benj. H. Sanborn and Co.

The authors have been guided by the National Committee on Mathematical Requirements. Hence much of the difficult work which has but little value, but which has been included formerly in texts of this grade, has been omitted. The course begins with the formula. Negative number is introduced through methods used in scoring. The statistical graph and functional graph have been used as often as seems wise. Numerical trigonometry of the right triangle is included. J. M. K.

An Introduction to the Mathematical Analysis of Statistics, by C. H. Forsyth, Assistant Professor of Mathematics, Dartmouth College. Pages VIII plus 241. 14x21 cm. 1924. John Wiley and Sons, Inc.

This is a textbook for a course in mathematics. It presupposes a knowledge of the calculus. The author has not followed the usual selection of topics, particularly in including numerical computation and finite differences. The typography of the book is excellent. J. M. K.

Introductory Algebra. A First Course for Secondary Schools and Junior High Schools, by Alan Johnson, Head of Mathematics Department, Barringer High School, Newark, N. J., and Arthur W. Belcher, Head of Mathematics Department, East Side Commercial and Manual Training High School, Newark, N. J. Pages V plus 389. 13x19 cm. 1924. F. M. Ambrose Co.

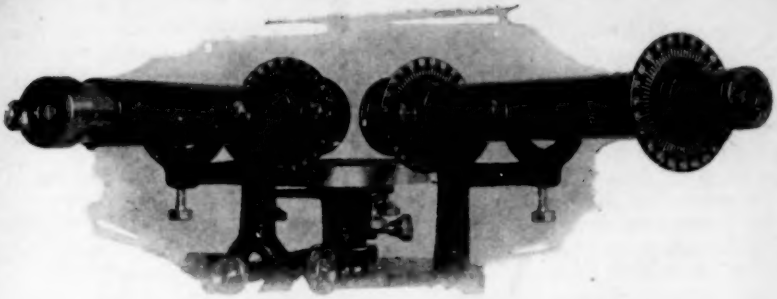
The authors of this book have given expression to the new spirit in secondary mathematics as set forth by the National Committee on Mathematical Requirements and as defined by the College Entrance Examination Board in an unusually happy manner. Much practice in the construction and evaluation of formulas is provided throughout the course. There is a large number of good problems. Much use is made of graphs in connection with negative numbers, tabulations, formulas, and in exhibiting relationships between quantities. A table of square roots and tables of tangents and sines are found in the appendix. J. M. K.

A Companion to Elementary School Mathematics, by F. C. Boon, Principal Mathematical Master, Dulwich College. Pages 302. 14½x22 cm. 1924. Price $4.50 net. Longmans, Green and Co.

This book is intended to be a companion to the elementary mathematics taught in the English schools. It contains chapters on such topics as Euclids Postulates, Squaring the Circle, The Theorem of Pythagoras, Symmetry, Analogy, Complex Numbers, Limits, Induction, The Principle of Proportional Parts, and Paradoxes and Fallacies. It is an excellent reference book for teachers of secondary mathematics.

J. M. K.

The Teaching of Mathematics in the Elementary and the Secondary School, by J. W. A. Young, Ph. D., Associate Professor of the Pedagogy of Mathematics in the University of Chicago. Pages XVIII plus 451. 1924. 14x20 cm. Price $2.20. Longmans, Green and Co.



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This is a third edition in which a few very minor corrections have been made in the main text. A supplement of 96 pages dealing with developments in the teaching of mathematics in the period of 1913-1923 has been added to the earlier editions. J. M. K.

Junior High School Mathematics, by William L. Vosburg, Head of the Department of Mathematics, Teachers College, City of Boston: Frederick W. Gentleman, Late Junior Master, Department of Mathematics, The Mechanics Arts High School, Boston: and Jasper O. Hassler, Professor of Mathematics, University of Oklahoma. First Course. Pages VI plus 228. Second Course. Pages X plus 254. 13x19 cm. 1924. The Macmillan Co.

Among the features to be noted in the first course are the following: (1) the first chapter is a very interesting historical review of the development of number symbols; (2) emphasis placed on the estimate of the result and on rational methods of locating the decimal point; (3) the use of graphical methods in the interpretation and representation of number data; (4) the early and continued use of the equation as a mathematical tool.

There are chapters on equations, measurement, mensuration of plane figures, and percentage applied to business.

In addition to the features mentioned in the first course we find in the second course: (1) the combination of common and decimal fractions in the same exercise; and (2) the introduction of the idea of degree of accuracy possible in computations dealing with measured data.

There are chapters on arithmetic of the home, arithmetic of the farm and city; plane geometric figures with emphasis placed on constructions; and formulas employed in the mensuration of plane and solid figures.

J. M. K.

Junior High School Mathematical Essentials, by J. Andrew Drushel, Teacher of Pedagogy of Arithmetic, Harris Teachers College, St. Louis; and John W. Withers, Dean of the School of Education, New York University, New York. Book I for seventh school year. Pages XI plus 196. Book II for eighth school year. Pages XIII plus 237. 1924. 14½x19 cm. Lyons and Carnahan.

The authors assume that the teaching of the fundamental processes involving integers, common fractions, and decimal fractions has been completed by the end of the sixth grade. Book I, therefore, does not begin with drill exercises. In fact, the first chapter is headed "Using Graphs in Problem Solving;" the second, "The Table Solution in Problem Solving;" and the third, "The Equation in Problem Solving."

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